of large vines. Theridiidæ were found in meter boxes and barns; the Attidæ were collected in Imperial Valley under rocks; the Lycosidæ which were collected during the month of April, were found in the grass with the females carrying the egg cases. The young of Thomisidæ were found, no eggs having been collected.

The shape of the egg cases of the several species studied differed materially. Those of *Peucetia viridans* are, as Comstock describes it, "hemispherical in outline with small projecting tufts." The egg sac of *Aranea gemma* is a light brown "loose flocculent mass of silk enclosing the ball of eggs." The egg case of most of the Thomisidæ, Comstock describes as being "lenticular in form" and are usually formed of two equal valves united at the border, which presents a little circular fringe. The egg case of *Philodromus* is made up of two disks which are fastened closely to the bark of the trees and may be more than lenticular in shape. In the subfamily *Misumeninæ* the egg sac is sometimes free and sometimes suspended like a hammock in a retreat formed of leaves rolled or drawn together. In most cases after the egg sac is made, the female stops her wandering habits in order to watch it. The egg sac of *Latrodectus mactans* is made up of a round closely woven silk ball, hard on the exterior and soft on the interior. Dust soon collects on the egg sac which gives it a dirty white color. They are suspended from the web by a few loose threads. The Lycosidæ tie their children to their apron strings. The females were found in great abundance in the early spring holding the flat circular egg case firmly with their mandibles. These cases were held up off the ground when the female moved and were dropped if she was disturbed. In the confined specimens the female upon being disturbed would drop her bundle, but as soon as the disturbance was over she would pick up the case again. The Attidæ were all collected from a valley with a warm climate and seemed to resent the change when they were placed in the cooler atmosphere of the laboratory. Their egg cases were of a very fine soft white silk and were attached to the under side of a rock, using the rock as one side and building the nest around that side. One female laid her eggs in captivity. The case was the same as those on the rocks but one side of the glass was used as a foundation. As there were

no eggs of the trap door spider collected, I cannot consider the shape of the egg case and none of the authors of spider life histories describe it. Comstock speaks of finding one in Florida, but does not describe it.

The general shape of the egg cases of the different species studied, seemed to be the same in all of the egg cases of that species. Comstock says in regard to the constancy of the shape of the egg sac of the species, "The egg sac is not merely a covering made in a haphazard way; but is a more or less elaborate structure, made in a definite manner characteristic of the species." While one cannot determine the species or genus of a spider definitely by the shape of its egg sac, yet it is a small factor which might aid in telling the genus.

The young of the different species differed widely in the length of time of emerging. *Peucetia viridans* emerged in a month, *Arenea gemma* in from two to three weeks, *Lycosa* sp. in three weeks, *Phippdus* sp. was kept for seven months and then artificial help was given to open the sack. The eggs of most of these species hatched soon after being laid.

The spiders made one or more moults in the egg sac before emerging from the case. In the case of *Aranea* it was seen that a great pile of shed skins were exuded outside of the sac just before the young emerged and then while emerging from the sac they went through another moult, leaving their shed skins in the case or just outside on a line which they made. From observations it would seem as though this species moulted two or three times before emerging from the sac. "The young attids, having undergone the moult, shift their positions to the opposite end of the cocoon and then moult a second and even third time before egress; as is shown by the fact that one finds within the same cocoon three separate heaps of skins cast at different ages." The young with the aid of a great deal of heat emerged two weeks after the eggs were laid. They had not moulted at all and were very weak, and came from one end of the cocoon. The case that was left for seven months showed that the young had deposited their shed skins in three places before emerging, and having migrated from one end of the egg sac to the other. Wagner ('88) asserts in "La Mue"—

JOURNAL OF ENTOMOLOGY AND ZOOLOGY

VOLUME VIII, 1916

PUBLISHED QUARTERLY BY THE
DEPARTMENT OF ZOOLOGY OF POMONA COLLEDG
CLAREMONT, CALIFORNIA, U. S. A.

Contents of Volume VIII

The Octopod *Ocythoe* in California

S. S. BERRY

In the course of my review of the West American cephalopods published a few years ago (Bulletin Bureau Fisheries, v. 30, p. 275), I wrote of a well known group of pelagic Octopoda as follows:

"No other group at all approaches *Argonauta* in its assemblage of utterly distinctive characters, the nearest being the genera *Ocythoe* and *Tremoctopus,* which are not known to be represented in our waters."

That *Ocythoe,* at least, is a member of our fauna, I have long suspected, partly because of a specimen which was exhibited in one of the Los Angeles curio stores some years since, but ignorantly held at so inflated a figure, that it could not be obtained even for one of the university museums, and another without label, but thought to be from Southern California, which is now in the collection of the State University at Berkeley. A further bit of evidence, which to me savors strongly of this same animal, lies in a paragraph by the late Dr. C. F. Holder with regard to a specimen obtained by him at Avalon (Scientific American, October 16, 1909, p. 283). He wrote:

"It is given in all the textbooks, I believe, that the male of the argonaut is a minute animal hardly an inch long. This cannot be so in all species. I have a male which has a radiant spread of eight or nine inches, and is as large as the female. . . . The male of this species is large, and might readily be taken for an octopus, having its habits."

As a male *Argonauta* answering such a description as this would be a sheer absurdity, the lines quoted served at first to occasion me no little perplexity. Surely, however, the suggestion that Holder's specimen was a female *Ocythoe* and not an *Argonauta* at all, seems not only possible, but plausible.

These cases are all strong indications that *Ocythoe* belongs to our fauna but, in view of the obvious uncertainty attending each, no formal record of the fact has yet found its way into print.

A very large and finely preserved female, recently sent me by Prof. William A. Hilton, now settles the matter without question. This specimen (S. S. B. 453) was obtained from near Avalon, Santa Catalina Island, California, in the summer of 1915, by Mr. W. F. Hamilton. Unfortunately I have no comparative material from other regions available, so that with only the aid of such figures and printed descriptions as are at hand, the specimen cannot be distinguished from the Mediterranean *O. tuberculata,* described and named by Rafinesque just over one hundred years ago. As *tuberculata* happens to be the only species of the genus enjoying general recognition, and as it is a pelagic creature with the possibility of very wide dissemination, the identification seems nevertheless to be reasonably certain, though it should be admitted that the areas it is alleged to inhabit are so widely separated that adequate material may later reveal differences which will be thought worthy of recognition.

In addition to Mediterranean localities the species has been reported from Vineyard Sound, Massachusetts, from the West Indies, and from Japan.

The sexes in this genus, as in the related *Argonauta* and *Tremoctopus,* show such extreme dimorphism, that the description of one applies in scarcely a single particular to the other. The female *Ocythoe,* however, is very easily distinguished from other cephalopods by the large Octopus-like body, the ventral surface of which is very curiously ornamented with numerous conspicuous cartilaginous tubercles, connected by radiating ridges. The enormous and powerful funnel is also noteworthy.

The more important measurements of the present specimen are appended below, many of them necessarily more or less estimated.

MEASUREMENTS

Total length	440 mm.
Length of body (dorsal)	160 mm.
Length of body (ventral)	155 mm.
Tip of body to base of dorsal arms	170 mm.
Width of body	115 mm.
Width of head	74 mm.

Length of head	10 mm.
Length of funnel	64 mm.
Width of funnel opening	12 mm.
Length of right dorsal arm	275 mm.
Length of left dorsal arm	265 mm.
Length of right second arm	200 mm.
Length of left second arm	195 mm.
Length of right third arm	180 mm.
Length of left third arm	185 mm.
Length of right ventral arm	250 mm.
Length of left ventral arm	240 mm.
Diameter of largest suckers	9 mm.

Review of the Genus Macrotylus. *Fieb.*

(Hemiptera)

E. P. Van Duzee, Univ. California

This genus in common with others of the tribe *Phylini* has the aroliæ parallel with the claws and attached to them, at least at base. Here they are large, exceeding the very small claws. Like other genera in the division *Oncotylaria* they have the prosternal xyphus convex at base and more or less carinate on the margins at apex. In *Macrotylus* the presence or absence of a hamus in the cell of the wings seems to have little significance and an examination of numerous individuals would possibly show that it may be either present or absent in the same species. I have found it present in *amœnus, sexguttatus, regalis, infuscatus* and *essigi,* and absent in *tristis, lineolatus* and *dorsalis.* I have been unable to determine this point in the unique type of *multipunctatus.* Our species are mostly handsome, clearly marked insects. They may be distinguished as follows:

Apex of the closed elytra marked with six large white spots placed on the outer border of the cuneus and membrane. 1.

Cuneus without a basal white spot; membrane black with pale nervures and sometimes with white marginal spots. 2.

1. Color deep black; head greenish olive; basal spot of the cuneus sometimes yellow. 1. *6-guttatus* Prov.

   Color pale yellowish-green; cuneus and membrane blackish, strongly contrasting with the white spots, size very small. 2. *amœnus* Reut.

2. Color above pale testaceous marked with numerous distinct round black dots; head deep black with two green dots on the base of the vertex; membrane black with two white spots beyond the cuneus. 3. *multipunctatus* n. sp.

   Membrane without white marginal spots, the nervures only pale. 3.

3. Color clear yellow with a broad black dorsal stripe connecting with the black membrane. 4. *dorsalis* n. sp.

   Color sometimes yellow, then without a black dorsal vitta. 4.

4. Color of the elytra clear yellow with the clavus, narrow costal margin, apex of the corium and the membrane black; head and pronotum greenish marked with black. 5. *essigi* n. sp.
   Color never yellow with clearly defined black markings. 5.
5. Color above greenish-yellow obscurely clouded with fuscous, becoming darker on the pronotum, clavus and middle field of the corium; membrane black with the nervures clear yellow. 6. *lineolatus* Uhl.
   Color black red or testaceous, never greenish-yellow. 6.
6. Color testaceous, more or less infuscated leaving the costal margin pale; above thickly clothed with pale pubescence. 7. *infuscatus* n. sp.
   Color black or red, the costa never pale. 7.
7. Color slaty-black with the nervure of the membrance conspicuously white. 8. *tristis* Uhl.
   Color dull red, the costal margin slenderly black, the head and callosities sometimes black. 9. *regalis* Uhl.

1. *Macrotylus 6-guttatus* Prov.

A very distinct deep black opaque species with the head polished and olive green or even yellowish before; the apex of the second antennal joint and the apical one-half of the tarsi fulvotestaceous. The cuneus has a large oval yellow or white spot at base and the apex is white. Near the end of the membrane is a large white marginal spot and there is a small one close to the white apical portion of the cuneus. I swept four examples of this interesting form from a low bush at Aylmer, near Ottawa, Ont., June 30, 1912.

2. *Macrotylus amœnus* Reut.

This is a very small species, scarcely 2½ mm. to the tip of the membrane. It is pale yellowish-green with the cuneus and membrane fuscous and marked exactly as in the preceding species except that the apical white spot is smaller. The antennæ are fuscous with pale incisures, and the feet pale with the anterior edge of the femora and the tibiæ and tarsi fuscous or black. The type of this species was taken in Connecticut by Dr. W. E. Britton, Mrs. Slosson has taken it at Delaware Water Gap, Pa., and I took a very small example at Estero, Fla., in May.

3. *Macrotylus multipunctatus* n. sp.

A little broader than *lineolatus* and its allies; pale testaceous closely dotted above with distinct round black points. Length 3¾ mm. to the tip of the membrane.

Head as in *6-guttatus,* more vertical than in *lineolatus* and the allied forms. Vertex nearly flat, collar-like; front convex, especially anteriorly; clypeus very prominent and polished. Pronotum as in *6-guttatus,* shorter than in the *lineolatus* group, its carinate sides rectilinear; anterior angles scarcely rounded but not dentate as in *6-guttatus.* Basal lobe of the scutellum broadly exposed. Eltyra rather wide, the sides distinctly arcuated toward their apex. Antennæ short, the basal joint little surpassing the tip of the clypeus. Cell of the wing without a hamus.

Color pale testaceous tinged with yellow on the scutellum and on the median line and anterior margin of the pronotum. Head black, polished on the clypeus; vertex with two squarish pale green spots connected anteriorly with a very slender line. Pronotum, scutellum and elytra ornamented with distinct round black dots, each dot carrying a stiff black hair; incisure of the scutellum on either side and the basal lobe anteriorly marked with black. Membrane blackish, the nervures clear white; margin with two large whitish-hyaline spots beyond the tip of the cuneus, separated by a deeper black one. Antennæ black, the incisures white, the middle of the second joint broadly testaceous. Legs testaceous, extreme apex of the femora white preceded by a black annulus; tibiæ narrowly black at either end, the tarsi black. Beneath fuscous, the edges of the ventral segments white. Genital segment and region of the stomata black.

Described from a single male example taken by me on the flats near the lower end of Fallen Leaf Lake, California, July 17, 1915. This is a very distinct species easily recognized by its pale upper surface closely dotted with rather large black setigerous points.

4. *Macrotylus dorsalis* n. sp.

Clear lemon yellow; membrane and a linear dorsal line black. Length 3½ mm. to the tip of the membrane.

Head as in the foregoing species, nearly vertical. Vertex scarcely flattened; front strongly convex, especially anteriorly. Clypeus

very prominent, its base deeply incised. Eyes rather small, viewed from the side oval, reaching hardly below the middle of the side of the head. Antennæ short, basal joint scarcely surpassing the clypeus; second a little more than twice the length of the first; third and fourth together a little longer than the second. Pronotum short, its carinate sides feebly concavely arcuated, the hind margin depressed, nearly covering the basal lobe of the scutellum. Upper surface sparsely clothed with deciduous black hairs.

Color, a pale lemon-yellow, sometimes tinged with green on the anterior margin of the pronotum and on the lower surface. Head more or less obscured or sometimes with a fuscous median line. Pronotum with a median fuscous longitudinal vitta, sometimes widened so as to cover the callosities. Scutellum infuscated with its basal angles yellow. Closed elytra with a rather broad black commissural vitta. Membrane black with the nervures pale at apex about the smaller areole. Apex of the tibiæ and tarsi black.

Described from one male and four females taken by me on Adenostoma at Alpine, San Diego County, California, April 8, 1913, and one female taken by Mr. Fordyce Grinnell at Pasadena, California, April 30, 1909. This species is easily distinguished by its clear yellow color with a black dorsal vitta.

5. *Macrotylus essigi* n. sp.

Dark green; antennæ, legs and disk of the pronotum black; elytra clear greenish-yellow, the clavus, costal nervure, broad apical margin of the corium and the membrane black, the latter with yellow nervures. Length 4 mm. to tip of membrane.

Head a little more oblique than in the foregoing species. Vertex narrowly flattened, the front becoming strongly convex toward its apex; clypeus as in the allied species. Eyes small, viewed from the side oblong, reaching about half way to the gula. Pronotum long, the sides straight and scarcely carinate. Basal lobe of the scutellum well exposed. Elytra nearly parallel, a little widened posteriorly. Antennæ rather short, the basal joint just surpassing the clypeus; the second over three times the length of the first; apical two together longer than the second. Rostrum long, reaching on to the base of the venter. Legs long, the hind tibiæ as long as the corium.

Genital segment of the male very large, polished, occupying one half the length of the abdomen. Oviduct of the female long, beginning before the middle of the venter.

Color dark green, more or less varied with black or fuscous. Vertex green with two minute black points at the middle; front more or less broadly bordered with fuscous. Clypeus black, the cheeks usually green. Ponotum black with the lateral margins and sometimes the median line green, the callosities more or less broadly yellow. Scutellum greenish-yellow, the middle of the basal lobe black. Elytra clear greenish-yellow with the clavus, linear costal margin and apical vitta on the corium black. Cuneus entirely yellow. Membrane black, deeper beyond the areoles, the nervures conspicuously yellow. Beneath infuscated along the middle, the genital segment black and polished. Antennæ and legs black, the hind femora with a green line. Upper surface clothed with short deciduous black hairs.

Described from two males and two females taken by Mr. E. O. Essig on chaparral growing among the hills at Berkeley, California, July 7, 1915. It gives me pleasure to dedicate this strongly marked species to its discoverer who is well known for his studies on the Aphididæ and for his work in economic entomology.

6. *Macrotylus lineolatus* Uhler

This and the following two species belong to a group having a more elongated body with the head subhorizontal, the pronotum much narrowed anteriorly with its sides feebly sinuated and sharply carinate as far forward as the transverse impressed line, the rostrum long, surpassing the base of the venter and the elytra parallel or slightly sinuated. The colors here are more subdued and uniform without the striking patterns we find in the preceding species.

In *lineolatus* the color is a peculiar shade of greenish-yellow over almost the entire body. The upper surface is sparsely clothed with short fuscous hairs and is clouded with fuscous on the posterior field of the pronotum, excepting the sides and median line, on the clavus and on the disk of the corium within the principal nervure, more distinct apically. These dark markings on the elytra are often nearly obsolete or they are represented mostly by blackish punctures.

Cuneus pale. Membrane infuscated with a short blackish ray at apex of the areole, the nervures yellowish. Antennæ black with pale incisures; the feet infuscated with the base of the femora pale. I took numbers of this neat little species about the lower end of Fallen Leaf Lake, near Tahoe, California.

7. *Macrotylus infuscatus* n. sp.

Allied to the preceding; dull fuscous with the costal margin pale or largely pale, sometimes greenish-testaceous in the female. Length 5 mm.

Head subhorizontal. Vertex scarcely flattened, the front becoming strongly convex anteriorly as in the typical forms of this genus, with a deep constriction at the base of the clypeus. Clypeus prominent, a little produced at apex as in many of our species. Eyes large, viewed from the side nearly vertical and reaching much below the middle of the side of the head. Antennæ rather long; the basal joint surpassing the apex of the clypeus by one-half its length; second two and one-half times the length of the first; the third about equal to the second; fourth flattened and about equal to the first. Pronotum long, strongly narrowed anteriorly, scarcely half as wide before as behind; sides sharply carinate throughout, a little sinuated, the humeral angles prominent. Elytra parallel or slightly widened behind; wing cell with a hamus.

Ground color pale testaceous; tinged with greenish on the pronotum, head and beneath; shaded with fuscous, especially in the males; pronotum, excepting the lateral edges and sometimes the callosities, scutellum except the outer angles of the basal lobe, and the elytra except the costal margin, more or less deeply infuscated, sometimes becoming a blackish-fuscous; disk of the front at times infuscated, the clypeus usually black and polished. Cuneus usually pale or decolored. Membrane deeply infuscated with pale nervures and a small black ray beyond the tip of the areoles. Antennæ black with pale incisures, often with a broad pale annulus on the second joint. Legs pale, the femora more or less dotted with fuscous; the knees, tips of the tibiæ and the tarsi black. Above clothed with long gray pile giving the insect a hoary aspect.

Described from numerous examples taken about the lower end of Fallen Leaf Lake, California, in July, 1915.

8. *Macrotylus tristis* Uhler

This is a dull slaty-black insect about the size of the preceding, becoming polished beneath and on the unusually prominent clypeus. There are two minute pale spots on the vertex and there may be two more on the callosities and two on the basal and two on the apical lobe of the scutellum; the membranal nervures, basal margin of the cuneus and commissural nervure beyond the apex of the clavus calloused and white. Wing cell without a hamus. Basal joint of the antennæ scarcely surpassing the clypeus, the antennal incisures and knees white. The whole upper surface is rather sparingly clothed with pale pubescence.

I took numbers of this sombre looking species on the hills about Lakeside and Mussey's, San Diego County, California, during April and May, 1913.

9. *Macrotylus regalis* Uhler

I took three males of what I am identifying with some doubt as Uhler's *regalis* from Adenostoma at Alpine, San Diego County, California, in June, 1913. These are smaller than Uhler's unique female, measuring but three and one-half millimeters to the tip of the membrane; the anterior lobe of the pronotum is red like the posterior, the vertex and front have a median red vitta; the pectoral surface and abdomen are red instead of black and the membrane is infuscated with the nervures pale. Most of these differences represent merely an extension of the red color which may be characteristic of the male sex.

In this species the head is almost horizontal with the apex more produced than in any of our other species and the basal joint of the antennæ is shorter, not attaining the apex of the clypeus. The upper surface is of an almost uniform dark sanguinous, sparsely clothed with fine pale pubescence and showing some dark markings about the callosities and along the median line of the pronotum and scutellum. It is peculiar in having the apical antennal joint conspicuously flattened, much more distinctly so than in our other species of the genus.

New Californian Mites

Nathan Banks

The following new specias form part of an interesting collection of mites recently sent by Dr. Hilton for determination:

Trombidium perscabrum n. sp.

Red. Body about one and one-half times as long as broad, subpyriform, broadest at humeri, broadly rounded behind. Cephalothorax very short, with crista reaching almost to the hind margin and there enlarged, and with a long fine hair arising from each sensilla. Eyes near lateral margin on a very short elevation. Body clothed with short, capitate hairs with roughened tips, some near the eyes are longer than the others. Among these capitate hairs are tufts of shorter spine-like hairs. Legs also clothed with similar, but mostly more clavate than capitate hairs, roughened on sides and end; some of the apical joints beneath have more slender hairs, and tarsus I. has them only on the base above, elsewhere with long, fine hairs. Leg IV. is about as long as the body, the last joint as long as the penultimate; leg I. plainly shorter than the body, tarsus I. fusiform, longer than the penultimate joint and about twice as broad. Palpi rather stout, basal joints with clavate hairs above, below with simple or pectinate hairs, and similar hairs on the fourth joint. Thumb as long as third and fourth joints together, cylindrical, rather longer than the claw.

Length, 1.4 mm.

From Claremont, California, January.

Differs from *T. scabrum* in having the clavate hairs on legs and palpi, and in the cylindrical thumb.

Erythræus posticatus n. sp.

Body dark (probably red in life), legs pale. Body about one and two-thirds times as long as broad, broadly rounded behind, as broad at hind coxa as at humeri; cephalothorax narrowed in front, crista short, swollen at hind end, one eye spot each side. Body and legs clothed with simple hairs, not very densely, and about as long

as width of basal joints of legs; tarsus I. with shorter hairs, those below very short and dense. Leg I. about as long as body, tibia and metatarsus subequal, tarsus nearly two-thirds as long as metatarsus, and a little broader, but not greatly swollen, leg IV. plainly longer than body, the femur reaching beyond the tip of abdomen, the tibia only about two-thirds as long as the metatarsus, the tarsus hardly one-third as long as the metatarsus, and only slightly swollen. The palpi short and not much enlarged, the claw rather short and slender, the thumb slightly clavate, reaching beyond end of claw, and with hairs about one-half as long as the width of the joint.

Length, 2 mm.

From Claremont, California.

Tarsotomus macropalpis n. sp.

A large species, rather sparsely bristly. Body nearly twice as long as broad, broadest at humeri; cephalothorax tapering in front, one eye spot each side close to margin and much nearer hind than front end of cephalothorax; legs long, but none of the femora as long as the cephalothorax, the tibia (penultimate joint), however, as long as the cephalothorax; body and legs with erect bristles, only a few very long ones, some on the basal joints are serrate or hairy, and the outer frontal pair, which are thicker than the others, also hairy. Claws with rows of bristles beneath; palpi very large and heavy, with two apical claws, the large one with a few teeth on inner side, hairs of thumb very short.

Length, .7 mm.

From Claremont, California, under rocks.

Tarsotomus terminalis n. sp.

Body slightly constricted in the middle, each part slightly rounded and a little broader than long; legs long and slender, the hind femur as long as abdomen, the hind tarsus one and one-half times as long as femur; front femur about as long as hind femur; palpi long, ending in a slightly curved, stout spur, thumb long, but also heavy. Body and legs (except tarsi) with many very long, nearly erect bristles, two or three times as long as width of hind femur; tarsi with shorter, more appressed hairs. Cephalothorax with two eye spots each side.

Length, .4 mm.

From Claremont, California.

Eupodes brevipes n. sp.

Body yellowish (probably red when alive), legs hyaline. Body slender, pyriform, plainly more than twice as long as broad, much the broadest at humeri, above the hind coxæ the sides are concave, tip broadly rounded. Cephalothorax subtriangular, two long bristles each side, one on humerus, and two submedian rows down the back, about six bristles near tip of body. Leg I. no longer than body, femur I. not as long as the width of the body, tarsus I. plainly longer than penultimate joint which is no longer than the one preceding it. Leg IV. not as long as the body, the basal joints not much enlarged, tarsus IV. plainly longer than penultimate joint. All legs with a few simple bristles, mostly near tips of joints.

Length .45 mm.

From Laguna Beach, California, June 8th.

EXPLANATION OF PLATE

Figure 1. *Erythræus posticatus;* palpus, legs I. and IV.
Figure 2. *Trombidium perscabrum,* crista, palpus, and hairs.
Figure 3. *Tarsotomus macropalpis,* palpus, tarsal claws, and tip of mandible.
Figure 4. *Eupodes brevipes,* palpus and leg I.
Figure 5. *Tarsotomus terminalis,* palpus.


I
IV
1
2
3
4
5

An Interesting Basket Star From Laguna Beach

The specimen here recorded was obtained by a fisherman off the coast of Laguna Beach at a depth of nearly a thousand feet. It was sent to Dr. H. L. Clark for determination and the following notes about it are quoted from his letter. The photograph here shown is very much reduced from the original.

Basket Star from Laguna Beach. (Much reduced)

"It is a remarkable example of *Gorgonocephalus eucnemis* (M. and T.), not previously recorded from south of San Francisco, although it may be well known to Pacific coast collectors.

"It is *not* the form of *eucnemis* described by Lyman from San Francisco as *G. caryi* but is a typical example of *G. japonicus* de-

scribed by Döderlein from Tokyo Bay. My opinion (previously published) that *caryi* and *japonicus* are synonyms is thus strongly confirmed.

"It is the largest ophiuran, by far, hitherto recorded. Its disc is about 130 mm. across. The largest specimen I have seen hitherto is 115 mm. Döderlein, in his monograph, has 110 mm. as his maximum measurement."

W. A. Hilton.

A Remarkable Pycnogonid

William A. Hilton

In a collection of a thousand pycnogonids obtained at Laguna Beach and nearby a single specimen of the species here described was found. This was taken near Laguna under a stone at low tide. The two-jointed proboscis, the segmented body, the long tapering legs with their peculiar spines and hairs, these and other features were distinctive.

After searching through the rather extensive literature of this group it was found that few species resembled this one. Epecially was the proboscis different. The genus *Ascorhynchus* established by Sars in 1876 seems very close to it, but there are a number of slight differences. No species in this genus is like it. The genus *Eurycyde,* Schodte, 1857, as described by Sars in his great work of 1891 seems to fit this specimen exactly. The species *E. hispada* Kroyer, as described and figured by Sars seems at first to be nearly the same as the specimen at hand, but a careful examination shows numerous specific differences. Sars considers this *E. hispada* the only species of the genus described at that time, 1891. I have found no species of this genus described since. *E. hispada* Kr. has been found on the coast of Greenland, Finmark, Nordland, in the Kara sea; at a depth of 50 to 191 fathoms.

Eurycyde spinosa n. sp.

Type specimen—a female in the collection of Pomona College. Total length 3.085 mm. Extent from side to side 3.6 mm. (obtained from a preserved specimen mounted on a slide). Collected at low tide under a rock, Two Rock Bay, Laguna Beach, California, September, 1915.

Trunk rather broad. Lateral processes long, swollen caudally. Segments of trunk plainly marked from each other. Chitin thick. Caudal segment long slender. It projects upwards at a moderate angle and bears four large hairs or spines near the end, two of these are central, two are more lateral.

The eye tubercle just in front of the ovigers, projects nearly straight up in the unmounted specimen. It bears four eyes and is pointed. One large hair and several smaller ones project from it.

The proboscis is two-jointed, the basal joint is narrower and cylindrical. The terminal joint is swollen in the middle and tapers at the tip, and tapers a little less at the base. The proboscis is bent at the base of the terminal joint and the tip points backwards under the animal.

In the freshly killed animal the legs and all the leg-like appendages were easily seen from above, but in the slide the ovigers did not show from above nor do they in the figure.

The chelifori are three-jointed, the terminal joint is small, slightly lobed but not chelate. The other segments are of nearly the same length but the basal one is thicker. There are a number of long spine-like hairs on the middle joint and one large one on the basal joint.

The palpi are ten-jointed, the two basal joints small, the five terminal joints are also small and bear fine hairs.

The ovigers are nine, possibly ten, jointed, rather larger than the first two appendages and quite a little longer than the body. In the fresh specimen this appendage looks much like a leg from above. There are two claws, the terminal larger. The terminal joints bear a number of complicated spines and knobs as shown in the figure.

The legs are broad at the body and taper towards the claws. The basal joint is provided with a single large spine. The narrower second joint bears two spines. The third joint is smaller and bears no spines. The fourth joint is usually about twice the length of the last and bears five spines at the end. The fifth joint bears several spines on the shaft as shown in the figure. The sixth joint is about as long as the fifth and bears spines on the shaft as shown in the figure of the four legs. The last two joints bear only a few smaller hairs. There is one slightly hooked claw on each leg.

The wide lateral processes of the body, the first angular joint of the legs, the complicated spines of the oviger and the different arrangement of spines on appendages and body clearly separate this species from the other members of the genus.

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(Contribution from the Zoological Laboratory of Pomona College)

Figure 1. *Eurycyde spinosa* n. sp. from above. Drawn by means of projectoscope from mounted specimen. X25.

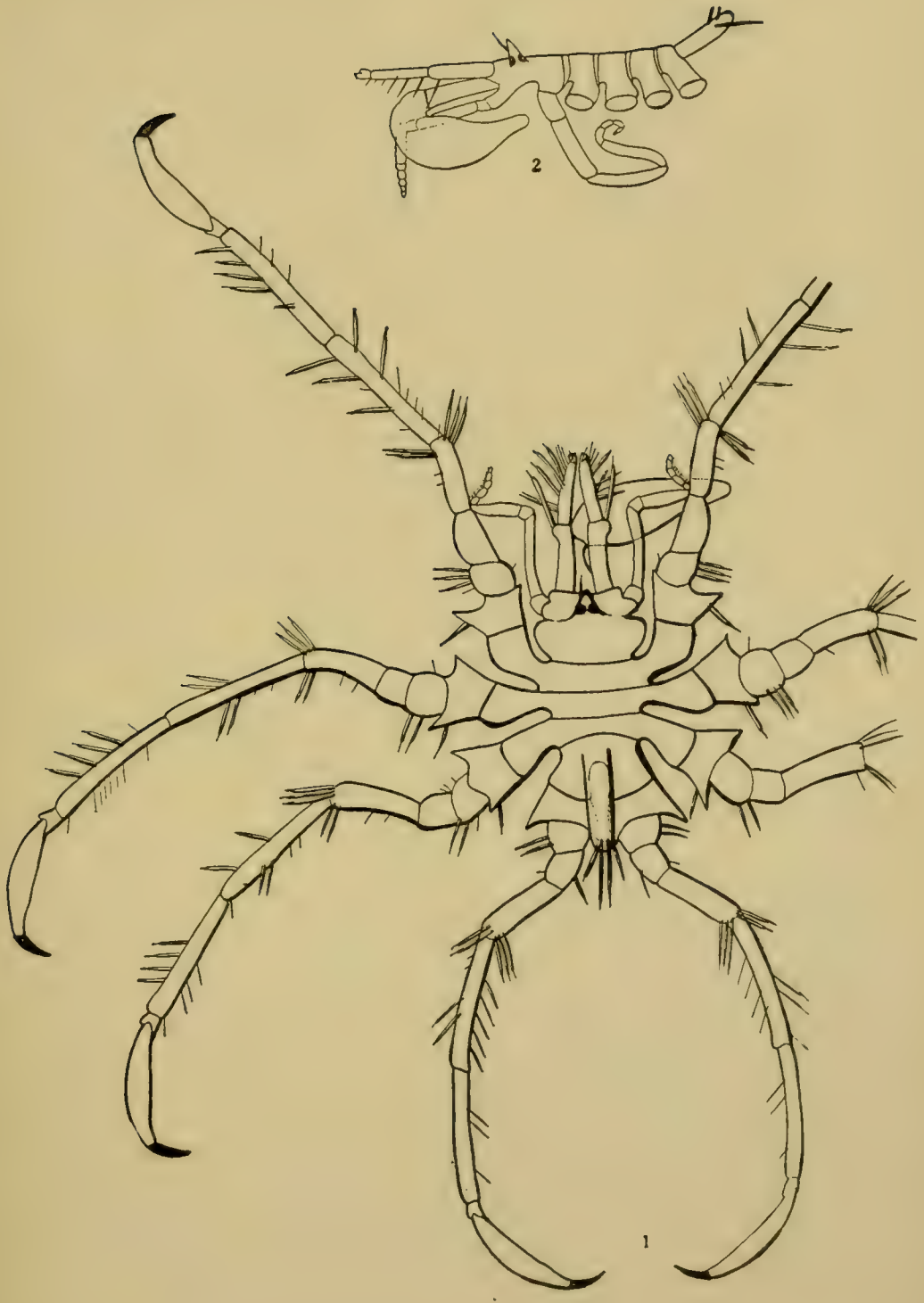
Figure 2. *Eurycyde spinosa* n. sp. from the side, legs not shown. Less magnification than fig. 1.

Figure 3. Right chelifor, not all of basal joint shown. X75.

Figure 4. Right palpus. X75.

Figure 5. Oviger from the right side. X75.

Figure 6. Tip of first leg, from the right side. X75.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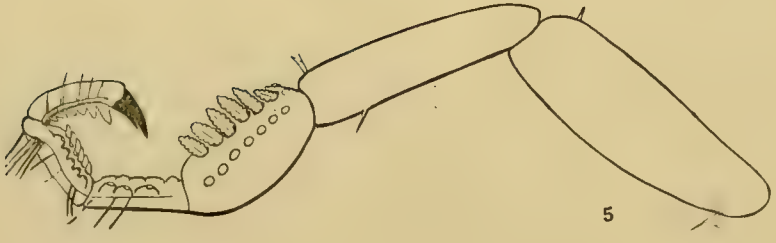

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The Life History of *Anoplodactylus Erectus* Cole

WILLIAM A. HILTON

As an introduction to the statement of the life history of this species it may be worth while to briefly review something of the literature on the subject and follow this with all that is known of our Californian or Laguna Beach forms.

The fact that the males carry the eggs after laying was first determined by Cavanna in 1877. The eggs are large or smaller according to the yolk present. In *Phoxichilidium* and *Tanystylum* studied by Morgan, the eggs are .05 mm., in *Palene,* .25 mm. In certain species of *Nymphon* they have been described as large as .5 to .7 mm. in diamater, Dohrn, '81. The egg masses are one or more for each leg. In *Palene* there are only two eggs in each group, but according to Dohrn there may be a hundred or more in each bunch. In some cases both legs hold a single mass. Segmentation is complete and equal in the smaller eggs, unequal in the larger. The best account of the later development is given by Meisenheimer for *Ammothea* in 1902. A typical gastrula is formed by an ingrowth of cells from the uniform almost solid previous stage. This gastrula however has no cavity, but later it forms into midgut and dorsal and lateral parts, the sources of the heart, muscles and connective tissues. Later there is a longitudinal germ band about the yolk and in this, paired thickenings appear which represent the cerebral and subesophageal ganglia, lateral thickenings mark the point of origin of the appendages. The chelifori are the first to appear. In *Palene* (Morgan) the fourth leg is next, then the fifth and sixth. The third and seventh come just before hatching.

Palene and some other forms such as some species of *Nymphon* have in the larva all of the appendages of the adult, but most free larvæ are provided with three pairs of appendages. Such are called protonymphon stages. In various species these appendages differ somewhat, but in practically all, the body is similar at first. The body during early larval stages is roughly circular in outline, the

first appendages are short, strong and chelate, the other two appendages are more slender and may be moderate in length or very long. All appendages or only one or two may be provided with long spines near the base. Two types of protonymphon stages may be recognized, the most common such as found in species of the genera, *Nymphon, Ammothea, Tanystylum, Zetes* (*Eurycyde*), by Dohrn, Hoek, Morgan, Meisenheimer, Meinert and others.

The genus *Pycnogonum* is in a way an intermediate type for the first appendage bears a long hair-like process, as shown by Hoek, '81, and Meinert, '98.

The genera *Phoxichilidium* and *Anoplodactylus* have long tendril-like extensions from the two body appendages. These larvæ were first noticed by Gegenbauer in 1854, among hydroids, later by Allman '59, in a similar situation. Both of these investigators supposed that the eggs of *Phoxichilidium* were laid in the hydroids. Hodge in 1862 showed that it was the larva which made its way into the cavity of the hydroid polyp. Semper 1874, gives a very good outline of the life history of *P. mutilatum.* Adlerz in 1888 gives more detail in the larval stages of *P. femoratum.* A large number of others have described parasitic habits of pycnogonids besides those already mentioned. Hallez in 1905 speaks of the mutual modifications of larvæ and hydroid, various degrees of parasitism were found in different species. In one case the larvæ were from .1 mm. to .8 mm. in length in different stages, the last stage being somewhat elongate in form. Mertens in '06 found a larva in *Tethys* which he described as a new species of *Nymphon.* Loman '08 was one of the latest to consider this kind of parasitism among pycnogonids. Some earlier writers who also considered this subject were Kroyer '42, Lendenfeld '83, and Strethill '63.

Among the Laguna Beach pycnogonids the eggs were held by the males in from two to sixteen bunches. *Palene* has about two eggs in two clusters. *Halosoma* had from six to eight small bunches. *T. intermedium* had usually about four. *T. orbiculare* from two to four clusters. *L. marginatus,* usually four. *A. spinosissima* about 11 bunches. *A. californicus* sixteen small bunches of many eggs. *A. erectus* sixteen. The eggs differ greatly in size in the different species. The eggs of *Halosoma* are the smallest yet recorded,

.02 mm. *A. erectus* are .03 mm. in diameter, *A. californicus* .035, *A. spinosissima* .0425, *A. bi-unguiculata var. calif.* .0575, *T. intermedium* .06, *A. tuberculata* .0675, *L. marginatus* .065, *Palene californiensis* .175. All measurements were from preserved eggs.

Palene was found to have immature stages much as has been given by Morgan for this genus and Meinert for *Pseudopalene.* The larvæ of *Ammothella, Tanystylum, Clotenia, Lecythorhynchus* so far as determined were not provided with the long hair-like appendages. The other genera not mentioned at this time were not obtained in sufficient numbers to draw any conclusions. *Anoplodactylus* of the two species found were provided with the long appendages in early stages.

On the piles at Balboa bay, great masses of hydroids of several species may be found, the species which is most abundant seems to be *Tubularia crocea* Ag. Living among these hydroids are spider crabs, amphipods and other crustaceans, molluscs, and other hydroids. Among a mass of old tangled stems in a single location a large number of adult males of *A. erectus* was found bearing egg masses in all stages from the egg up to the first larval stage. Figs. 1 and 2 are drawings from such stages. This was in the first week of September, 1915. Earlier in the same year Mr. F. W. Daniels brought me some hydroids that were literally swarming with pycnogonids. These were from the same locality. In these hydroids were found the stages shown in Figs. 3 and 4. These larvæ were very abundant in the digestive cavities of nearly every polyp. In some cases three or four might be found in one place. Swarming over the surface of the hydroids were the more mature stages, some small, others larger but at this particular place none of them mature. Many were such as shown in Fig. 5 with the fourth pair of legs represented by lobes at the caudal end of the body. Judging from the observations made, eggs are produced in summer and early fall; the long-armed first stage larvæ come from the males at various times and as they reach the hydroids the long appendages are lost, probably by a moult and then by two distinct stages such as shown in Figs. 3 and 4, they grow in size, three pairs of legs grow out and they leave the interior of the polyps and live for a time in the immature state clinging to the gonosome or tentacles of the hy-

droids. In the last of November of the same year not a single larva, immature form or adult, was found although a very thorough search was made of the surface and interior of the polyps and dead stems.

Figs. 1, 2 and 3 are drawn to the same scale, X350. In Fig. 6, a number of stages from the egg to the latest larval stage is shown, all drawn at the same scale. Stage *b* probably moults upon entering the polyp; as judged from the cast skins, there is probably a moult between *c* and *a,* and *d* and *e*. As shown in Fig. 3, there are little knobs left just ahead of the limb buds. These knobs are the vestiges of the whip-like appendages of the earlier stage. According to Semper these two appendages degenerate completely, Adlerz believes that some vestiges of these remain and in their place the second and third limbs of the adult are formed. Meinert believes that the second and third appendages of the larva entirely disappear and the palps and ovigers are new structures. I am sure from the examination of many embryos of *A. erectus* that the larval second and third appendages disappear beyond recognition and that the ovigers develop after the animal is almost an adult, but I am not sure that the little knob which may be seen in parasitic and later stages does not represent the ovigers. If this last be true, it would be very difficult to prove that it was an entirely new structure, because it grows out from the place where the third larval organ disappears. The chelifori of the larval stages are continued directly to the adult condition. Very little of the internal structure is shown from the surface of the earliest stages. The nervous system is not shown as a distinct area in earliest larval stages although it is well shown and well developed in the similar stages of other larvæ. It may be that the probable lack of activity may not necessitate the sharp demarkation of the brain and ganglia. Later parasitic larval stages show well-marked ganglia for the larger appendages and smaller ones for the caudal and cephalic ends. At the caudal end there seems to be a gradual development of the ganglia with the development of the caudal end of the animal and in some free living forms there seem to be at least two pairs of ganglia beyond the thoracic or leg ganglia. At the cephalic end it is more difficult to make accurate observations. In parasitic

stages there seem to be from one to two distinct ganglia which may be those of the ovigers and palps. In addition to these there were found from one to two isolated pairs of what were taken to be ganglia in the proboscis.

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(Contribution from the Zoological Laboratory of Pomona College)

EXPLANATION OF FIGURES

Figure 1. Embryo of *A. erectus* Cole X350. The embryo was taken from the female.

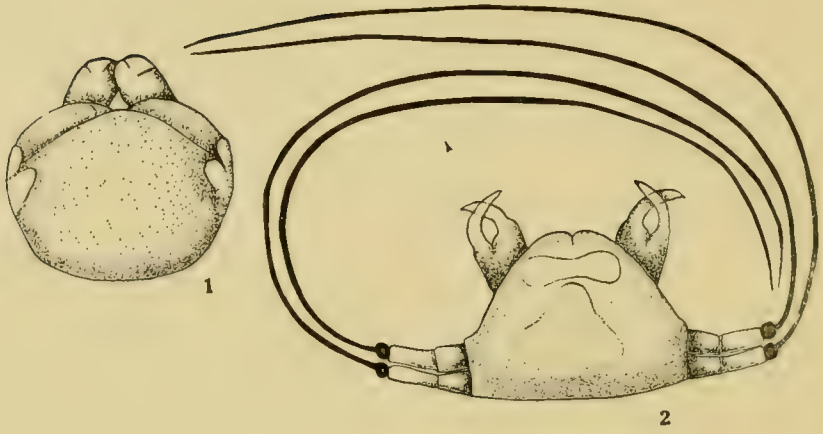
Figure 2. Larva of *A. erectus* Cole X350. Just hatched larva with appendages straightened.

Figure 3. Larva taken from the digestive tube of the hydroid. X350.

Figure 4. Much later larva of *A. erectus* taken from the digestive tube of a hydroid. This is much less enlarged than the last. X75.

Figure 5. Free living immature specimen of *A. erectus,* taken from the surface of a mass of hydroids. X35.

Figure 6. Outline of stages in the early life history of *A. erectus.* All figures drawn to the same scale X50. (a) Egg, (b) just hatched larva, (c, d, e and f) parasitic stages all found at the same time in two polyps.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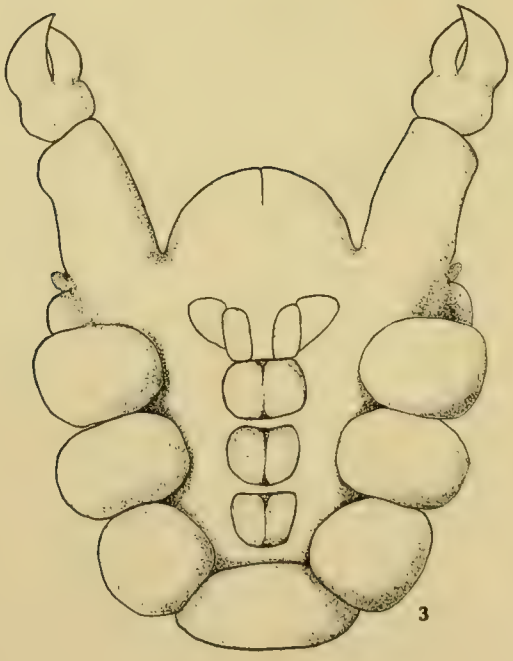
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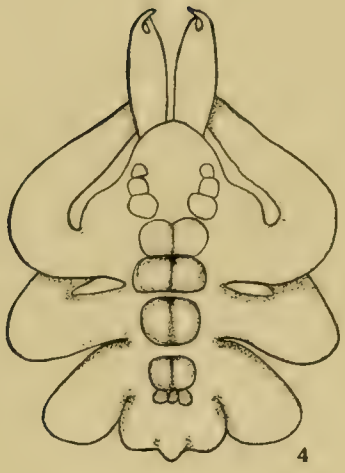

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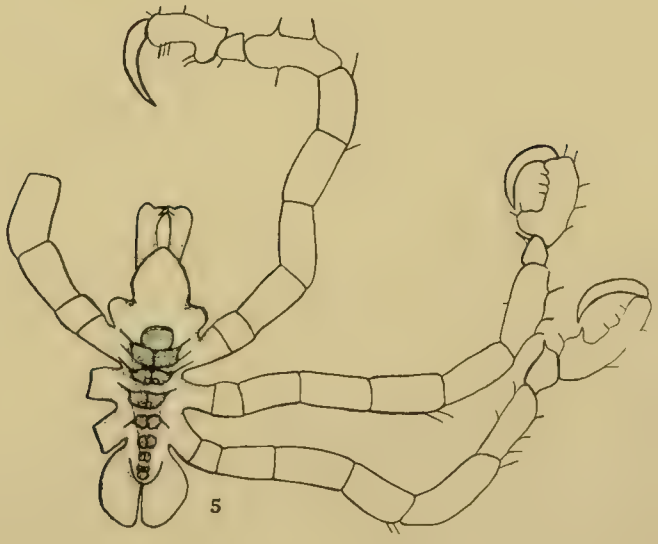

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Mites From the Claremont Laguna Region

The mites listed below were collected during the years 1914 and 1915, chiefly in the fall. Those from Claremont were for the most part collected and mounted by Miss M. Shaw, Miss P. Jahraus and Mr. F. Cox. The mites from Laguna were collected by W. A. Hilton. The determinations were made by Dr. Nathan Banks, who describes several of the species as new in this issue. Immature forms were only determined to genus.

1. *Parasitus* sp. (nymph). Under leaves, Claremont. Cox, Shaw, Jahraus.
2. *Rhagidia pallida* Bks. Under stones, Claremont. Cox, Shaw.
3. *Erythræus* sp. (nymph). Under stones, Claremont. C. S. J.
4. *Tarsotomus terminalis* Bks. (this issue). Claremont, on live oak. C. S. J.
5. *Erythræus augustipes* (?) (nymph). Under stones, Claremont. J.
6. *Erythræus augustipes* Bks. Under stones, Claremont. S.
7. *Bella lata* Ewing. On live oak and under stones, Claremont. C. S. J.
8. *Erythræus augustipes* (?) (nymph). On live oaks, Claremont. C. S. J.
9. *Trombidium perscabrum* Bks (this issue). Palmers canyon, near Claremont. C. S. J.
10. *Eremæus bilamellatus* Hall. Claremont, under leaves. J.
11. *Tarsotomus macropalpis* Bks. (this issue). Claremont, under stones. S.
12. *Tarsotomus terminalis* Bks. (this issue). Claremont, under stones. J.
13. Hydracnid larva (large, bright red). On Notonecta, Claremont. H.
14. *Uropoda* sp. (nymph). Dark brown, closely massed on Scolopendra from Claremont. H. Fall of 1913.
15. *Erythræus augustipes* Bks. Under the bark of an eucalyptus tree. Claremont. H. Fall of 1913.

16. *E. posticatus* Bks. (this issue). Under the bark of an eucalyptus. Claremont. H. Fall of 1913.
17. Hydracnid larva, bright red on Notonecta. Laguna Beach. H. July, 1915.
18. *Parasitus* sp. (nymph). Dark reddish brown, on a large staphleinid beetle found about six miles from Laguna Beach. H.
19. Hydracnid larva, dark brown, found on a carabid beetle. Laguna Beach. H.
20. *Uropoda* sp. (nymph). Dark reddish brown, found on a carabid beetle, Laguna Beach. H.
21. *Hydracna* sp (?) "probably new." Banks. This large, dark brown spherical mite was found in great abundance on the pond weeds at the "Lakes," Laguna Beach. Specimens were collected in July and August, 1915. H.
22. *Eupodes brevipes* Bks. (this issue). Found under leaves in a canyon north of Laguna Beach. H.
23. *Eupodes brevipes* Bks. (this issue). Found at Laguna Beach, under stones. H.
24. *Erythræus* sp. (larva). Bright red, found abundantly on our most common phalangid. Palmers canyon. October, 1915. H.
25. *Erythræus* sp. (larva). Found abundantly on the neck folds and about the head of the common horned toad of Laguna. The hosts were collected high on the hills to the southeast of the laboratory. H.
26. *Trombidium perscabrum* Bks. (this issue). Found in the fresh water of Aliso canyon, near Laguna Beach. Color, bright red. H.

W. A. Hilton.

(Contribution from the Zoological Laboratory of Pomona College)

Summer School at Laguna Beach

Once more the advantages of the Laguna Marine Laboratory have been enjoyed by a considerable number of students and investigators. During the summer of 1915 about thirty students registered for courses in Marine Zoology, Entomology and General Biology. There were also a number of the students who took special work. In addition to these in various courses, there were about twelve students and investigators from eastern and northern colleges and universities, who stayed a day, a week, a month and in some cases for longer periods throughout the summer.

Laguna Marine Laboratory and Tent City

The new tent city with its rooming and housekeeping tents, and dining hall for the first time furnished ample accommodation at a reasonable price to all who stayed at the Summer School or visited the Laboratory.

In the aquarium room an exhibition of local animals was open at all times. During the season over two thousand people visited the aquarium and museum. Evening lectures were given during the Summer School and these were always open to the public.

Near Two-Rock Point, Laguna Beach

During the season of 1915 more interesting and valuable specimens were obtained than in previous years. Very few of these have yet been worked over for publication.

The beautiful coast line, both up and down from the Laboratory, was more extensively explored than in other years, yet there are many places not carefully examined at low tide. Inland also more

An Arch Above Laguna Beach

field trips were taken, to canyons, to caves, to hill-tops and along streams. The Lakes up Laguna Canyon were found to be almost as interesting as the rocks at low tide. There was not time last summer to any more than to begin to touch the possibilities of the region.

It is rather interesting to note that the students as a whole did better class work than in Claremont. This may partly be due to lack of pressure of outside activities, and partly due to the enthusiasm developed by the study of animals in their natural environment, but still there were some diversions which helped to pass the time pleasantly. Saturday was used for the more or less optional field exercises. Early mornings when the tide was low were also used for field work. After four P. M. every day, time was usually taken for bathing or short walks and on some evenings there were beach suppers.

During the coming summer more courses will be offered and a number of visitors and investigators are expected.

The tent city and dining hall will again offer accommodations at reasonable prices. The cost of tuition will be as last year; that is, $7.50 general charge and $2.00 an hour per hour taken. By an hour is meant the equivalent of an hour's work in a regular college semester. There are eight private rooms for special investigators.

For further information write to the Director, William A. Hilton, Pomona College, Claremont, Cal. (Laguna Beach, Cal., from June 22 to September 20.)

Courses Offered at the Summer School of the Laguna Beach Biological Laboratory 1916

To reach Laguna Beach from Los Angeles take the electric or Santa Fe to Santa Ana. From Santa Ana a morning stage leaves at ten, an afternoon stage at four.

Work begins June 26th and regular courses last six weeks, but the laboratory is open all summer.

No one may register for more than six hours. By an hour is included the equivalent of an hour's work during a regular college semester.

1. S. B. 11. Zoology (2 hours). A synopsis of marine invertebrates. Lectures and class exercises with early morning field trips. Prerequisite Biology A1, or open to those who are taking some other biological work. M. to F. at 8. Prof. W. A. Hilton and ————.

1a. S. B. 11. Zoology. Marine invertebrates (1 hour if taken with 1, or 2 hours). Laboratory on typical local forms. Mornings 9 to 12, except Saturday. Prof. W. A. Hilton and ————.

2. S. B. 18. General Entomology (2 to 3 hours). Class laboratory and field work in the general study of local insects. Prerequisite Biology A1, or Zoology B11, or may be accompanied by one of these. Class period M. to F. at 11. Lab. and field work at hours to be arranged. Prof. W. A. Hilton and ————.

3. S. A1. General Biology (3 hours). A beginning course dealing with general principles. Open to those who have had no biological work and who have either entered college or are about to enter. Class periods M. to F. at 1. Lab. and field work afternoons. Prof. W. A. Hilton and ————.

4. S. C. 4. Ecology (2 or 3 hours). Class field and laboratory work at hours to be arranged. A study of local land and aquatic societies and the factors governing the distribution of marine, fresh water and land forms. Prerequisite, a year of biological work. Prof. A. M. Bean.

5. S. C. 5. Seaweeds (2 or 3 hours). Chiefly a study of marine Algæ. Prerequisite a good general course in Botany. M. to F. at 8. Field and laboratory work at hours to be arranged. Prof. A. M. Bean.
6. S. B. 6. Birds (2 hours). This course is designed to acquaint the student with the birds of Southern California—their classification, habits, haunts and songs. Some attention will be given to structure, development, and the problem of migration. Emphasis will be laid upon their economic relations. Lectures three times a week. Laboratory and field work to be arranged. Prerequisite one year of biological work. Prof. H. H. Nininger.
7. S. D. 7. Mammalian Embryology (2 hours). Lab. work with serial sections of embryos. Prerequisite two years of zoological work. A review course for those in the practice of medicine or preparing for medical work. Hours to be arranged.
8. S. D. 8. Human Neurology (2 hours). Laboratory work with sections of the human brain and cord. A review course open only to those who have some knowledge of the central nervous system of vertebrates. Especially designed for those who have interest in Neurology, Psychology or Medicine.

In addition to these courses special C. or D. work for 2 or 3 hours may be taken as follows:

a. Special field and laboratory work with some group of marine animals, such as amphipods, isopods, decapods, gastropods, etc.

b. Special field and laboratory work in Entomology, either with some single order or family, or life history work.

c. Special field and laboratory work in the embryology of invertebrates.

d. Special field and laboratory work in Ecology. Hours to be arranged.

e. Special field and laboratory work in marine algæ. Hours to be arranged.

There will be, as last summer, special nature-study work given to younger pupils. Adapted for children from nine to fifteen.

New and Little Known Bees From California

By T. D. A. Cockerell

The bees described and listed below are from the Baker collection, and were kindly transmitted to me by Professor Wm. A. Hilton. All are from Claremont or the vicinity.

Glossoperdita gen. nov.

Like *Perdita* Smith in general structure and appearance, but mouth-parts enormously elongated, apparently not retractile, the end of the tongue reaching beyond tip of abdomen; maxillary palpi 6-jointed, slender and very short, about 300 microns long; maxillary palpi about 1280 microns from base of mouth-parts, the blade extending about 3200 beyond the palpi, but the labial palpi not correspondingly elongated, their ends only about 800 microns beyond insertion of maxillary palpi. Head narrow, facial quadrangle conspicuously longer than broad; facial foveæ elongate and deep, ending below about level of insertion of antennæ; b. n. falling far short of t. m.; second s. m. very broad (long) but much narrowed above; stigma small and narrow; marginal cell long for the group, broadly truncate at end.

Glossoperdita pelargoides sp. n.

♀ Length about 5 mm.; not very robust; pubescence scanty, white; head and thorax blue-green, but the mesothorax only green in front, the greater part, as well as the scutellum, black; clypeus and supraclypeal area black, sparsely and distinctly punctured; the face apparently without light markings, but close inspection shows a broad shadowy pallescent band in middle of clypeus, and similar triangular pallescent lateral marks, hardly visible; flagellum bright ferruginous beneath except basally; front dull; mesothorax shining anteriorly, the median groove deep; pleura polished, shining; tubercles pale reddish, two small pale marks on upper border of prothorax; legs piceous, hairy, anterior knees and band on tibia pale yellowish, middle knees pale reddish; tegulæ reddish; wings short,

somewhat dusky, stigma and nervures pale sepia; abdomen orange-ferruginous, without markings above or below, hair at apex pale ochreous.

Habitat: Claremont, California (*Baker;* Pomona coll. 227 part). Unfortunately the habits of this remarkable bee are unknown. *Glossoperdita* could be considered a subgenus of *Perdita*, but it seems distinct enough to deserve generic rank.

The other specimens collected by Baker at Claremont sent under 227, are marked as from flowers of *Rhus laurina.* They consist of *Perdita rhois* Ckll., and a single male *P. hypoxantha* Ckll., the latter presumably a stray, as the species is attached to *Adenostoma.* Also under 227 is a female of *P. albipennis* Cress., collected by Baker at Los Angeles, and bearing his number 691.

Perdita ruficauda, sp. n.

♀ Length about 5.5 mm., moderately robust, pubescence scanty; head and thorax dull olive green; head ordinary, inner orbits parallel; mandibles pale yellow suffused with reddish, the apex black; clypeus black, sparsely punctured, with a broad pale yellow median band, failing below; no supraclypeal mark; lateral marks pale yellow, triangular, produced above, ending in a sharp point on orbital margin at level of antennæ; flagellum pale fulvous beneath; tubercles yellow with a dark dot, and a pair of cuneiform yellow marks on upper border of prothorax; mesopleura shining; legs piceous, with anterior and middle knees, tarsi and tibiæ yellow, the latter dark behind; tegulæ pellucid; wings faintly reddish, stigma and nervures reddish-brown; stigma small and slender; marginal cell large, obliquely truncate at end; abdomen bright orange-ferruginous above and below, without markings, except a narrow dark stripe along lateral margins of second segment. Mouth-parts not especially elongated; labial palpi with first joint about 690 microns, the other three together about 290 microns. Maxillary palpi long and well-developed.

Habitat: Claremont, California (*Baker;* Pomona coll. 229, 199). This superficially resembles *Glossoperdita.* In my tables of *Perdita* it falls near *P. chamaesaracha,* from which it is at once known by the face-marks and the palpi.

Halictoides mülleri Ckll.

Both sexes were taken by Baker at Claremont.

Hesperapis nitidulus sp. n.

♂ Length a little over 6 mm.; shining black, with white hair; eyes pea-green; mandibles broad, red and notched at end; head large and broad; flagellum very obscurely reddish beneath; tegulæ piceous in front, testaceous posteriorly; wings hyaline, nervures and stigma dusky ferruginous; abdomen with rather thin hair-bands. near to H. *larreæ* Ckll., but mesothorax with very minute regular punctures; area of metathorax dull and abdomen more shining. Easily known from *H. oliviæ* Ckll. by the clearer wings and dark antennæ.

Habitat: Claremont, California (*Baker;* Pomona coll. 229).

Agapostemon californicus Crawford.

Claremont (*Baker*). A male with the scape all dark; it usually has a yellow stripe in this species. *A. radiatus* Say was also taken by Baker at Claremont.

Panurginus atriceps (Cresson)

Mountains near Claremont (*Baker;* Pomona coll. 204).

Andrena osmioides sp. n.

♂ Length about 10 mm., robust, very hairy, looking like an *Osmia;* head, thorax and legs black, abdomen olive-green, the surface minutely granular, not polished or punctate; hair of head and thorax white, dullish and faintly creamy above, very long and abundant, forming an immense white beard over mouth; abdomen with erect or sub-erect pale hair, all over the surface but not dense, long on the first two segments, apex with pale soot-colored hair; legs with pale hair. Head extremely broad, facial quadrangle very much broader than long; malar space very short; cheeks very broad, obtusely angled behind below level of middle of eye; antennæ ordinary, third joint equal in length to next two combined; flagellum very obscurely reddish beneath; vertex dull, only shining on orbital margin; mesothorax dull, not punctate, but scutellum anteriorly shining; area of metathorax dull and granular, with long erect hairs like the adjacent parts; tegulæ piceous; wings dusky on apical mar-

gins; stigma narrowly lanceolate, very slender, ferruginous with dark margin; b. n. meeting t. m.; first r. n. joining second s. m. much before middle; second abdominal segment depressed less than a third; venter purplish.

Habitat: Claremont, California, at flowers of *Cryptanthe* (*Baker;* Pomona coll. 198). Easily known among the species with green abdomen by its large size, abundant long pale hair, and very slender stigma.

In the mountains near Claremont Baker took *A. mimetica falli* Ckll., and at Claremont *A. prunorum gillettei* Ckll.

Andrena prunorum var. *mariformis* v. n.

♀ Clypeus pale yellow with two black spots, exactly like that of a male. The hair on head and thorax above is fine fox-red; the abdominal hair-bands are pale fulvous. Scape partly red, especially at apex; flagellum wholly dark. Second abdominal segment with a large black discal patch.

Habitat: Claremont, California (*Baker;* Pomona coll. 207). This is not stylopized. Can it be a partial gynandromorph? All the characters, including the antennæ, are those of a female, except the clypeus.

Andrena peratra sp. n.

♀ Length about 10.5 mm.; entirely black, with black hair, except perhaps partly on mesothorax, which is denuded in type; head very broad, facial quadrangle very much broader than long; malar space very short; process of labrum obtusely pointed; clypeus delicately roughened, with rather close weak punctures, no smooth line; front minutely striate; facial foveæ dark seal brown, occupying more than half the distance between antennæ and eye, ending below, far below level of antennæ; third antennal joint considerably longer than next two combined; flagellum obscure reddish beneath except at base; mesothorax dull, granular, with no distinct punctures; area of metathorax granular; pleura with long reddish-black hair; small joints of tarsi reddish; tegulæ piceous, largely ferruginous posteriorly; wings translucent reddish, not dark; stigma ferruginous, narrowly lanceolate, extremely slender; nervures fuscous; abdomen granular, without evident punctures, but moderately shining; second

segment depressed about a fourth; hair at apex reddish-black; ventral segments with long fringes of stiff black hairs.

Habitat: Claremont, California (*Baker;* Pomona coll. 199). This may be compared with *A. nigerrima* Casad, from which it is readily known by the non-punctate abdomen and other characters.

A related but much larger species of the Los Angeles region is *A. subtristis* Ckll. This, according to Mr. Viereck, is a synonym of *A. nigra* Prov., and the specimens in the National Museum labeled *nigra* are this species. There is, however, some confusion, since Provancher's description indicates a smaller species (length .42 inch), with a smooth line in middle of clypeus (wholly wanting in *subtristis,* but present in the much larger *pertristis* Ckll.), wings smoky reddish (like *pertristis* rather than *subtristis*), and abdomen oval and brilliantly polished. This indicates a species unknown to me.

Andrena auricoma Smith

Claremont (*Baker;* Pomona coll. 197). Smaller than an Oregon specimen. *A. candida* Sm. was also taken by Baker at Claremont (Pomona coll. 198).

Andrena plana Viereck

Claremont (*Baker;* Pomona coll. 212). This is a little larger than Viereck's type, but is presumably his *plana,* having the very remarkable brownish velvet-like hair on thorax above, and the dull impunctate clypeus. The second abdominal segment has no apical depression. Superficially the species resembles *A. mustelicolor* Vier., but it is easily separated by the thoracic hair.

Andrena opaciventris sp. n.

♀ Length about 10 mm.; black, with fulvous hair, bright fox-red on thorax above; face and front with much fulvous hair, so that the dull granular surface of the clypeus is difficult to see; mandibles black, with a red spot at extreme base; process of labrum narrow at end, minutely notched; facial foveæ grayish-brown, about half as wide as distance between antenna and eye, difficult to see on account of the long overlapping hair; antennæ black, third joint 368 microns long, the next two together 384 microns; mesothorax and scutellum

dull, without distinct punctures; area of metathorax dull, defined by absence of hair; hair at sides of metathorax very long and curled; legs with pale hair, largely chocolate on outer side of middle and hind tibiæ, pale orange on inner side of basitarsi; spurs pallid; tegulæ black; wings slightly dusky, stigma ferruginous, nervures fuscous; b. n. meeting t. m.; first r. n. joining second s. m. about middle; abdomen broad, with a completely dull impunctate surface; first segment with long fulvous hair at base, and a patch on each side on hind margin; segments 3 to 5 with conspicuous entire fulvous hair-bands; apex with pale soot-colored hair, a sort of reddish-gray; second segment depressed about a third, but the depression obscure.

Habitat: Claremont, California (*Baker;* Pomona coll. 197). Resembles *A. auricoma,* but very distinct by the opaque abdomen.

Andrena chlorura sp. n.

♀ Length nearly 8 mm.; olive green, the metathorax, legs and antennæ black; pubescence fulvous, bright fox-red on thorax above and tubercles; some thin black hair on front and vertex; process of labrum very broad and rounded; clypeus with sparse weak punctures; facial foveæ black, rather narrow, ending below at level of antennæ; third antennal joint longer than next two together, but not so long as next three; mesothorax dull, impunctate; area of metathorax dull; tegulæ piceous; wings dusky; stigma large, dark reddish; nervures fuscous; abdomen shining, impunctate, with thin narrow fulvous hair-bands on segments 2 to 4, but none on first; hair at apex black; second segment depressed about a third in middle, but very narrowly at sides.

Habitat: Mountains near Claremont, California (*Baker;* Pomona coll. 197). A pretty species, known among the green Andrenæ by its red hair and small size. In Viereck's tables of *Andrena* of the N. W. States it runs near to *A. chlorinella* Vier., from which it is quite distinct. According to Viereck (litt. 1907) *A. xanthostigma* Vier. is identical with *chlorinella.*

Diandrena beatula sp. n.

♀ Length 7 mm., or slightly over; olive green, with a minutely sculptured sericeous surface, not polished; pubescence dull white,

forming felt-like hair-bands on abdomen, weak on first segment, but broad and conspicuous on 2 to 4; hair at apex of abdomen very pale ochreous; mesothorax with thin felt-like pale ochreous hair, and a few long hairs intermixed; facial quadrangle broader than long; mandibles black; process of labrum deeply emarginate; facial foveæ light, with a slight ochreous tint; more than half as wide as distance from antenna to eye; apical two-thirds of flagellum bright red beneath; mesothorax dullish, granular; area of metathorax delicately plicatulate; tegulæ rufopiceous; wings faintly dusky; stigma dusky ferruginous, small and narrow; legs with white hair, hind tibiæ with a broad loose scopa; tegument of legs black; abdomen looking like that of the group of *Halictus* including *H. provancheri.*

Habitat: Claremont, California (*Baker;* Pomona coll. 216). A pretty little species, allied to the next, but easily known by the dullish fasciate abdomen.

Diandrena cyanosoma sp. n.

♀ (Type.) Length about 8 mm.; head olive green, thorax and abdomen blue green, the abdomen almost blue; clypeus black, with the upper and lateral margins green, the junction of the black and green suffused with purple; mandibles black; pubescence dull whitish; slightly ochreous on head and thorax above, fuscous or black just behind ocelli and more or less on front, and long dark hairs on scape; process of labrum narrow, emarginate; antennæ dark, the flagellum only very obscurely reddish toward end; facial foveæ pale, quite broad; mesothorax dull and granular, with short hair, and some long ones intermixed; scutellum rugosopunctate, but glistening anteriorly; area of metathorax roughened with very delicate rugæ; femora olive-green; tibiæ and tarsi black; hind tibiæ with a long glistening pure white scopa beneath, but fuscous hair above (behind), and hind knee-tuft grayish fuscous; hind trochanters with a long white curled floccus; tegulæ piceous; wings dusky, stigma dark reddish, rather small; abdomen broad, without any distinct hair-band, though the fourth segment has a thin fringe; hair at apex soot-color.

♂ More slender, with the usual sexual differences. Clypeus and middle of face densely covered with long white hair, but some

long fuscous hair at sides of front and on scape; cheeks with long white hair; mesothorax and scutellum with thin long erect white hair; abdomen quite without bands, hair at apex dark grayish-fuscous.

Habitat: Claremont, California (*Baker;* Pomona coll. 203, 229). A distinct species, readily known from *D. puthua* Ckll. (male) by the dark hair at apex of abdomen. The dull surface of the abdomen at once separates it from the two following species.

Diandrena clariventris sp. n.

♂ Length a little over 6 mm., robust, with broad-pyriform abdomen; head and thorax dull blue-green; legs black, the femora perhaps faintly metallic; abdomen polished, shining, very dark blue-green, the hind margins of the segments broadly subtranslucent brown; head very broad, facial quadrangle much broader than long; antennæ only moderately long, flagellum dark reddish; face and front with pure white hair, hair of thorax also white, no dark hair on head or thorax; area of metathorax granular, faintly plicatulate basally, and with a faint median raised line; tegulæ piceous; wings dusky; stigma and nervures reddish-fuscous, the stigma dark, not very large; hair at apex of abdomen very pale, with an ochreous tint.

Habitat: Claremont, California (*Baker;* Pomona coll. 212). Allied only to the next species, which is much smaller. *D. chalybæa* (Cress.), also taken by Baker at Claremont, has the abdomen shining blue.

Diandrena scintilla sp. n.

♀ Length about or hardly 5 mm., robust, with very broad abdomen. General characters as in *D. clariventris,* but much smaller; head nearly circular, seen from in front; flagellum very short and stout, the middle joints about twice as broad as long, dark reddish beneath; front shining, punctate; mesothorax and scutellum olive-green, shining, with distinct minute punctures; area of metathorax concave, finely striatulate; stigma and nervures paler than in *D. clariventris,* and wings not so gray; punctures on second abdominal segment sparse; hair at apex of abdomen light ferruginous.

Habitat: Claremont, California (*Baker;* Pomona coll. 213). Close to *D. clariventris,* but certainly distinct, the sculpture of the thorax being quite different.

Conanthalictus bakeri Crawford.

♂ About 4 mm. long; hair at apex of abdomen reddish-gray, abundant. The six-jointed maxillary palpi are very long and slender, and the tongue is linear, quite long, with very long hairs.

♀ I made the following notes from Crawford's type in U. S. National Museum. Dull green abdomen, hind margins of segments pale reddish; head round seen from in front; front dull bluish green; long hairs over clypeus like a moustache; mesothorax not evidently punctured. Has the short elevated clypeus of genus, but head differently shaped. The Claremont specimen shows a well-developed tibial scopa.

Two males and a female are before me, from Claremont (*Baker;* Pomona coll. 199, 216). The genus seems nearest to *Paralictus* Rob., but quite distinct. Both are without the caudal rima in female.

Conanthalictus macrops sp. n.

♂ Length slightly over 4 mm., but more robust than *C. bakeri,* with the reddish hind margins of abdominal segments fringed with white hair except in middle; head very broad, the facial quadrangle much broader than long; mandibles broadly red at apex; antennæ short, entirely dark; cheeks rather broad, with a depressed, dimple-like area; front completely dull, but mesothorax somewhat shining, though not polished; wings strongly dusky; stigma dark reddish, rather small; nervures fuscous; second s. m. very narrow; femora green, tibiæ and tarsi black, with white hair. The green color, fine sculpture, etc., are as in *bakeri.* The abundant hair at apex of abdomen is pale dusky reddish.

Habitat: Claremont, California (*Baker;* Pomona coll. 199). Known from all other members of the genus by the very broad head. The large black eyes are parallel.

Augochlora pomoniella Ckll.

Both sexes from Claremont (*Baker;* Pomona coll. 211, 210). The male is new.

♀ Antennæ entirely dark, flagellum with only the faintest red tint beneath toward the apex.

♂ Flagellum ferruginous beneath, except first and last joint; mesothorax polished, with well-separated punctures; first ventral segment of abdomen green with piceous margin, the others without metallic color; the second to fifth with straight hind margins, not emarginate, the sixth emarginate.

Osmia cyanopoda sp. n.

♀ Length nearly 10 mm., robust, deep indigo blue, the abdomen brilliant and shining; pubescence black, mixed with white on scutellum, and very slightly at sides of metathorax; antennæ black; femora and tibiæ strongly bluish or purplish; tegulæ with the anterior half blue; wings brown, paler along the veins; clypeus ordinary; mandibles tridentate; facial quadrangle longer than broad; mesothorax strongly and densely punctured; area of metathorax dull.

Habitat: Claremont, California (*Baker;* Pomona coll. 182). In the table in Ent. News, June, 1910, this runs to *O. gabrielis,* from which it is known by being smaller, face narrower, punctures of mesothorax distinctly larger and less crowded, scutellum with partly pale hair, and bluish tibiæ. The rich blue-purple color of the abdomen is exactly the same in both. Pomona coll. 181 (Mountains near Claremont, *Baker*) is *O. pogonigera* Ckll.

Osmia cyanosoma sp. n.

♀ Length nearly 7 mm.; deep indigo blue, the middle of the abdomen stained with greenish; hair black, mixed with fine short pale hairs on mesothorax; tuft behind wings, and hair at sides of metathorax and sides of first abdominal segment white; mandibles with two large sharp teeth and two minute ones. Very close to *O. tristella* Ckll., but separated by the partly pale hair on mesothorax, the distinctly metallic femora and tibiæ, tegulæ bright blue in front, hair of tarsi brownish, first r. n. joining second s. m. more remote from base. Also resembles *O. hypoleuca* Ckll. but is separated by the shorter second s. m., abundant black hair on scutellum, and black hair on tubercles. In *O. hypoleuca* there is a patch of glistening pale hair on lower part of pleura, and in *O. cyanosoma* there is

a similar patch, though less conspicuous. Another related but distinct species is *O. sanctæ-rosæ.*

Habitat: Mountains near Claremont, California (*Baker;* Pomona coll. 182, part). This may be a southern subspecies of *O. tristella.*

A totally different *Osmia* from Claremont (*Baker*), marked 182, is *O. novomexicana* Ckll., with the hair of the thorax above less brightly colored than in New Mexico specimens, but otherwise identical.

Osmia nigrobarbata sp. n.

♀ Length a little over 10 mm.; robust; head, mesothorax and scutellum dark green; pleura and metathorax much bluer; abdomen shining greenish-blue; legs black, without metallic tints; head broad; eyes pea-green; mandibles tridentate, the teeth very large; clypeus black (except borders), with dense coarse black hair, contrasting with pure white hair on sides of face; front and vertex with hair mixed black and white; upper part of cheeks with white hair, lower with more or less black; flagellum short, very obscurely reddish beneath; mesothorax and scutellum with extremely dense small punctures; area of metathorax shining except basally; mesothorax with thin white hair, with some black intermixed; tubercles with pale hair, but pleura with black; scutellum with abundant creamy hair, a few black intermixed; metathorax with black hair on lower part of sides, otherwise with pale; legs with black hair, more or less brownish on tarsi, a small tuft of pure white on posterior knees; tegulæ black, green in front; wings brownish, especially the broad apical margin; first r. n. joining second s. m. at a distance from its base equal to length of first t. c.; abdomen with white hair on first segment, scanty black hair beyond, but grayish-white on sixth and apical margin of fifth; scopa black.

Habitat: Claremont, California (*Baker;* Pomona coll. 182, part). Easily known by the contrasting black and white hair on face. It resembles *O. senior* Ckll., but differs by the shining area of metathorax, tridentate mandibles with large teeth, etc.

Osmia melanopleura sp. n.

♀ Length about 7.5 mm.; dark blue-green, densely punctured but somewhat shining; facial quadrangle longer than broad; mandi-

bles tridentate, the teeth large; clypeus extremely densely punctured; head with mixed white and black hair, the white conspicuous at sides of face, the black especially abundant on lower half of clypeus; antennæ black; thorax above with creamy-white hair, with black sparsely intermixed; metathorax with light and dark hair mixed; pleura with black hair (no patch of light hair below); legs black, with mainly black hair; tegulæ black, with a green spot in front; wings dilute brownish; b. n. meeting t. m.; first r. n. joining second s. m. as far from base as length of first t. c.; abdomen shining, the first two segments with glistening white hair, the next three with very thin light and dark hair, the sixth appearing greenish (contrasting with the rich purple-blue of the fifth), and hoary with appressed white hair; scopa black.

Habitat: Claremont, California (*Baker;* Pomona coll. 182, part). Resembles *O. pikei* Ckll., but differs by the much more finely punctured clypeus, the much shorter vertex, the much more closely punctured abdomen, etc.

The following key separates the above mentioned species of *Osmia;* all females with black ventral scopa.

Hair of thorax above wholly or mainly black.....1
Hair of thorax above wholly or mainly light.....3
1. Very small, not quite 7 mm. long.....*cyanosoma* sp. n.
Larger 2
2. Tibiæ dark blue.....*cyanopoda* sp. n.
Tibiæ black .....*pogonigera* Ckll.
3. Small, about 7.5 mm. long.....*melanopleura* sp. n.
Larger 4
4. Hair of thorax above all pale ochreous.....*novomexicana* Ckll.
Hair of thorax above with some dark intermixed
nigrobarbata sp. n.

Nomada crotchii nigrior Ckll.

This was described from the female. The male (Claremont, *Baker*) has no red on the thorax, but there are four small creamy-white spots, two at the anterior corners of scutellum, and two on postscutellum. Clypeus all cream-colored except upper edge; third antennal joint little over half length of fourth; legs with more

black; abdomen with sublateral dark spots; apical plate minutely notched.

Nomada pyrrha sp. n.

♀ Length about 8 mm.; bright ferruginous red, without yellow markings, and practically without dark ones; mandibles simple; head very broad; third antennal joint a little longer than fourth; black between ocelli; mesothorax densely roughened, with three faintly indicated bands of darker red; post scutellum not yellow; metathorax with a dusky shade in middle below the enclosure; face, scape and front with scattered long fuscous hairs; thorax above practically hairless; sides of metathorax with a patch of white hair; a black patch near bases of middle and hind legs; tegulæ bright red, punctured; wings dilute brown, darker at apex; stigma ferruginous, nervures fuscous; b. n. going a considerable distance basad of t. m.; third s. m. much narrowed above; hind tibiæ roughened on outer side, but not distinctly tuberculate; abdomen dullish, minutely granular; sides apically with fuscous hair; fifth segment with a narrow band of shining white tomentum.

Habitat: Claremont, California (*Baker;* Pomona coll. 169). Closely resembles *N. californiæ* Ckll., but is evidently an entirely red *Xanthidium,* to be associated with *N. miniata* Sm., which however, has the third antennal joint much shorter than the fourth, and orange spots on the abdomen.

Nomada melanosoma sp. n.

♂ Length a little over 5 mm.; black, the body almost without light markings; hind margins of abdominal segments (fully half of second and third) obscurely brown; extreme sides of segments 2 to 5 with very oblique broad white stripes; mandibles simple, white at base; lower edge of clypeus very narrowly reddish, with a white mark on each side; malar space white; head broad; face covered with silvery-white hair; antennæ long, the flagellum thick, the joints swollen, obscure dark reddish beneath; third antennal joint about half length of fourth; vertex, cheeks and thorax (especially pleura and metathorax) with white hair; mesothorax dull, extremely densely rugoso-punctate; anterior legs in front, middle tarsi and apical part of femora in front, and apex of hind femora

in front, brownish-ferruginous; anterior femora with a whitish spot just before apex; tegulæ very dark reddish-brown; wings long, stigma (which is large), and nervures piceous; apex of wings strongly dusky; b. n. falling short of t. m.; abdomen dull, only the extreme margins of the segments glistening; shape of abdomen rather long-oval, wide in middle; apical plate deeply notched; venter, except at base, marked with white.

Habitat: Mountains near Claremont, California (*Baker;* Pomona coll. 171). A distinct little species, easily known by its color. It falls close to *N. obscurella* Fowler, but that is larger (7.5 mm.), with legs largely yellow, including the middle and hind basitarsi, which are entirely black in *melanosoma.*

Nomada subvicinalis Cockerell.

Two males from Claremont (*Baker*) differ a little from the type. One has small yellow spots at anterior corners of scutellum, lateral margins of mesothorax very narrowly reddish, lateral face-marks continued as slender lines part way up sides of front, and apical plate of abdomen quite broad. The other lacks the yellow patch on second ventral segment.

Nomada civilis Cresson.

Two males from Claremont (*Baker*) are peculiar for having the apical plate of abdomen entire. One is about 9 mm. long, and has large yellow spots on the metathorax. The other is about 7 mm. long, and has the metathorax all black. *N. civilis* is one of the most variable of bees, but it appears difficult to satisfactorily define subspecies. *N. edwardsii* Cress. is another yellow and black species found by Baker at Claremont.

Nomada erythrospila sp. n.

♂ Length about 7 mm.; long and slender; head and thorax black, with white hair, abundant on face, pleura and sides of metathorax; head transversely oval; front, mesothorax and scutellum dull and rugose; mandibles simple, pellucid white at base, fulvous in middle, and dark at apex; labrum creamy-white, covered with white hair; lower margin of clypeus and lower corners of face (with a linear extension upward along orbits) cream-color; an-

tennæ very long, third joint about half length of fourth; scape black; flagellum fulvous beneath, suffusedly blackened above; tubercles yellow, two minute yellow dots at anterior corners of scutellum, and two yellow spots on postscutellum, all these markings inconspicuous; legs black and ferruginous, some of the markings characteristic; the anterior tibiæ red with a black stripe on outer side, at the end of which is a cream-colored spot; the middle femora red in front, with a large black basal patch; the middle tibiæ red with a broad black band on outer side, and an apical cream-colored spot in front; the hind knees creamy-white; tegulæ ferruginous; wings reaching about to end of fourth abdominal segment, dilute brownish with a large clear patch in the subapical field; stigma dark, dusky red; b. n. going a little basad of t. m.; abdomen long and narrow, dull ferruginous, the segments with broad dark basal bands; segments 1 to 4 with large (largest on second) lateral creamy-white patches, the first two short and broad, the other two transversely elongate, each having upon it a clear red spot; fifth segment with the pale patches almost joined in middle, sixth with a broad pale band covering nearly all the surface; apical plate deeply notched; venter ferruginous with whitish and dusky markings.

Habitat: Claremont, California (*Baker;* Pomona coll. 172). A distinct little species of *Nomada* s. str. The abdominal markings suggest *N. crotchii* Cress., the male of which is not known, but the male of *N. crotchii nigrior* differs from *erythrospila* so much in form and face-markings, that we can hardly refer the latter to *crotchii.* In *N. crotchii* the first r. n. joins the second s. m. far beyond the middle, but in *erythrospila* it joins it at the middle. *N. marginella* Ckll., is allied to *N. erythrospila,* but the antennæ are quite different.

Nomada odontocera sp. n.

♂ Length a little over 7 mm.; rather robust, head and thorax black, densely rugosopunctate, but the large punctures of the mesothorax glistening; hair of head and thorax above pale fox-red, beneath dull white; head transversely oval; mandibles simple, yellow, red at apex; labrum yellow, not dentate; clypeus (except narrow upper margin) and lateral marks yellow, the latter extending

upward as rather narrow bands to about level of antennæ; scape stout, entirely yellow in front; third antennal joint much shorter than fourth, but more than half its length; flagellum thick, bright ferruginous beneath, black above, the joints conspicuously denticulate; tubercles yellow, but thorax otherwise all black; anterior coxæ unarmed; legs mainly red, but anterior and middle femora yellow in front, anterior femora black beneath, middle femora black behind except at apex; hind femora black, with the knees red, and a yellow spot at apex in front; hind tibiæ suffusedly blackish behind; tegulæ light ferruginous; wings ample, dusky at apex, stigma clear red; b. n. going a little basad of t. m.; first r. n. joining second s. m. well beyond middle; abdomen bright ferruginous marked with black and bright yellow; first segment black with a broad red band on which are two obscure dusky spots; all the segments with fuscous hind margins, second and third segments intense black at base; second to fifth segments laterally with yellow spots, very large on second, successively smaller on the others; sixth segment red; apical plate strongly notched; venter with two yellow spots on second segment.

Habitat: Mountains near Claremont, California (*Baker;* Pomona coll. 168). Allied to *N. undulaticornis* Ckll., but easily distinguished by the scutellum, which is not prominent or bigibbous, and by many details of the coloration. Also related to *N. denticulata* Rob.

N. elegantula Ckll. was also taken by Baker at Claremont.

Exomalopsis velutinus sp. n.

♀ Length about 9 mm.; black, with a rather long, not subglobose, abdomen; head broad, facial quadrangle broader than long; eyes gray; blade of maxilla broad to end, the inner half (longitudinally) pallid; labrum densely covered with pale ochreous hair; clypeus densely rugosopunctate, the lower margin dark red; face and front with long dull white hair; vertex smooth and polished; flagellum bright chestnut red beneath, except at base; thorax with pale ochreous-tinted hair; mesothorax polished, shining, with scattered punctures, only hairy at front and sides, and narrowly on hind margin; scutellum with similar sculpture and hairy border, but more closely punctured, and some short black hairs bordering

the disc; base of metathorax roughened but glistening; legs densely hairy, the hair pale ochreous-tinted; hind tibiæ and basitarsi with a very broad loose scopa, hair on inner side of hind basitarsi pale ferruginous; tegulæ piceous; wings rather short, faintly grayish, with a milky appearance in certain lights; greater part of abdomen densely covered with felt-like very pale ochreous pubescence, but apex with pale ferruginous; base of second segment with the hair so thin as to leave a dark band; first segment bare in middle, finely punctured; hind margin of first segment (tegument) broadly reddened, and the second and third the same, only in these the color is hidden by the pubescence; venter with bands of red-golden hair alternating with pale.

Habitat: Claremont, California (*Baker;* Pomona coll. 153). Very like *Melissodes stearnsi* Ckll., which is to be called *Exomalopsis stearnsi,* but readily distinguished by the shorter and relatively broader marginal cell, the well though finely punctured disc of first abdominal segment, and the much shorter third antennal joint (length 480 microns in *stearnsi,* 350 microns in *velutinus*). The apical plate of abdomen is much broader than in *stearnsi,* with straight sides. Both species look like some *Xenoglossodes,* from which the most conspicuous superficial distinction is the bare polished disc of mesothorax. A second specimen of *E. velutinus* bears the number 147.

Exomalopsis melanurus sp. n.

♀ Length about 8 mm.; black, abdomen oblong; light hair ochreous-tinted dorsally, dull white below; head broad; eyes pale grayish-green; mandibles red in middle; clypeus densely and strongly punctured; face and front with grayish-white hair; vertex shining; flagellum dusky ferruginous beneath except at base; mesothorax and scutellum with sculpture and arrangement of hair as in *E. velutinus;* legs with long pale hair, the copious scopa of hind legs wholly pale; a black brush at end of hind basitarsi; tegulæ piceous, wings faintly dusky; first abdominal segment with long pale hair, the broad hind margin bare except at sides, where there is a dense patch of hair, extreme margin (tegument) pallid; segments 2 to 4 with very broad dense felt-like ochreous hair-bands, the basal part of the segments exposed and appearing black; fifth segment and

apex densely covered with brownish-black hair, but there is a tuft of light hair on each side beneath.

Habitat: Claremont, California (*Baker;* Pomona coll. 148). This looks like *Anthophorula bruneri* Crawf., but is at once separated by the roughened disc of first abdominal segment, the black hair at end of abdomen, and the minute dark stigma; there is evidently no real affinity.

Melissodes pygmæa Cresson, from the description, is apparently an *Anthophorula* or *Exomalopsis;* indeed the description might well apply to *A. bruneri.*

E. velutinus and *E. melanurus* are not typical *Exomalopsis.* The genus as at present understood contains some rather diverse elements.

Bombomelecta maculata (Viereck)

Viereck described this as a variety of *B. separata,* but it seems to be a distinct species. A female from Claremont (*Baker;* Pomona coll. 162), has the spots on third and fourth segments quite large and quadrate, and there are small spots on the fifth.

Coelioxys megatricha sp. n.

♂ Length about 11 mm.; black, with bright ferruginous legs (the femora dusky beneath) and rather dark red tegulæ; no red on abdomen, above or below; mandibles dark red subapically; face and front densely covered with long white hair; antennæ black, third joint distinctly longer than fourth; vertex with very large punctures, which laterad of the ocelli are distinctly separated, leaving interspaces equal to the size of punctures; eyes pea-green, with very long hair; mesothorax and scutellum densely and very strongly punctured, middle of mesothorax with little longitudinal ridges; scutellum rounded behind, teeth at sides long, finger-like, slightly incurved; pleura and metathorax covered with long shaggy white hair; anterior coxæ with strong spines; anterior trochanters and femora with much white hair beneath; spurs red; wings clear, the apical margin broadly dusky; abdomen with white hair-bands at apices of segments; dorsum and sides of first segment closely punctured; second and third segments with very deep transverse impressions, and strongly punctured, the ridge just behind the impression with sparse punctures;

fourth and fifth segments with large triangular elevated areas, which are rather sparsely punctured; fifth segment with a small tooth on each side; sixth with dense white hair at base, at each side a long sharp tooth, the apical lobes far apart, each with two teeth, the upper short, little more than a salient angle, the lower long, flattened, rounded at end, divergent; fourth ventral segment not emarginate.

Habitat: Claremont, California (*Baker;* Pomona coll. 195). I wondered whether this could be the undescribed male of *C. coquilletti* Crawf., but it is larger than the male of that species would probably be, there are no hair bands bounding mesothorax or scutellum posteriorly, the vertex is not entirely rugose, and the abdomen is without red. From *C. novomexicana* it is easily known by the hair on eyes being more than twice as long. By the long hair on the eyes it resembles *C. ribis kincaidii* Ckll., which has black legs, and the apical teeth of abdomen closer together and almost parallel.

Coelioxys angulifera sp. n.

♀ Length about 11.5 mm.; black, strongly punctured, with white hair; lower margin of clypeus angularly produced and sloping a little outward; knees, tibiæ and tarsi dark red, the tibiæ with a strong blackish suffusion. Very close to *C. banksi* Crawf. (from Virginia), differing thus: teeth at sides of scutellum long; no band of white hair in scutello-mesothoracic suture; mesopleuræ with long hair (not very dense) all over; last ventral segment not so much extended beyond last dorsal. Except for the clypeus, it much resembles *C. moesta* Cress., differing in the much longer teeth at sides of scutellum, and much larger punctures at base of penultimate ventral segment.

♂ Length about 8 mm.; face and front densely covered with white hair; anterior coxæ with well-developed spines; legs darker, the tibiæ mainly blackish; fifth abdominal segment with a short spine on each side; sixth with a long spine on each side, and the apical lobes each with two spines, the upper much shorter than the lower; no median spine; fourth ventral segment entire. In my table of male *Coelioxys* (Canad. Entom., 1912, p. 170) this runs to *C. angelica* Ckll., the female of which is very different from *C. angulifera.*

Habitat: Claremont, California (*Baker;* Pomona coll. 195). The female is the type. Were the insects not separated by the whole breadth of the continent, I should suppose this a race of *C. banksi*. *C. novomexicana* (Ckll.) was also taken by Baker at Claremont.

Xenoglossa angelica Ckll.

Claremont (*Baker;* Pomona coll. 145.)

Tetralonia robertsoni Ckll.

A female from Claremont (*Baker;* Pomona coll. 153) agrees with one from Garrison, N. Y. Can there be any error in the locality label?

Ceratina neomexicana punctigena subsp. n.

♀ Length about 8 mm.; differs from typical *neomexicana* by the cheeks, which are strongly and quite closely punctured, except a narrow band along orbits. The wings are strongly reddened, and the mesothorax is sparsely punctured anteriorly. It is known from the superficially similar *C. tejonensis* Cress. (which Baker obtained at Claremont) by the green (rather than blue) color, the white tubercles, and the strongly punctured cheeks.

Habitat: Mountains near Claremont (*Baker;* Pomona coll. 174). Baker also took *C. acantha* Prov. and *C. arizonensis* Ckll. at Claremont.

Anthidium angelarum Titus

Both sexes were taken by Baker at Claremont, Calif. The male, not described by Titus, runs to *A. palliventre* in my table in Bull. So. Calif. Acad. Sci., 1904, p. 57. It differs from the insect there referred to *palliventre* by the bright chrome yellow markings and the distinct rounded excavation on each side of median spine at apex of abdomen. The clypeus and large cuneiform lateral marks are entirely yellow. The female has yellow stripes on tibiæ, not mentioned by Titus.

A. illustre Cress. and *A. tricuspidum* Prov. were also taken by Baker at Claremont.

Dianthidium provancheri Titus

This is the species which I recorded as *D. consimile* (Ashm.) in Bull. So. Cal. Ac. Sci., 1904, p. 5. A specimen of true *consimile*

was collected by Baker in the mountains near Claremont. The males may be separated thus:

Outer face of hind tibiæ with a large black mark; yellow band of scutellum broadly interrupted in middle; median tooth at apex of abdomen black at end.....*provancheri* Titus.

Outer face of hind tibiæ entirely yellow; yellow margin of scutellum not interrupted; median tooth at apex of abdomen long and entirely yellow.....*consimile* (Ashm.)

A male with pale markings, collected by Grinnell in the San Gabriel Mts., has the hind tibiæ as in *provancheri,* but the light band on scutellum, though narrow, is entire, and the median tooth at end of abdomen is rather brown than black at end. This is referred to *provancheri,* but it may be that the two names represent extremes in the variation of a single species.

Triepeolus ancoratus sp. n.

♀ Length about 8 mm., with ochreous markings and red tegulæ and legs. Very near to *T. callopus* Ckll., but smaller; mesothorax with two broad bands and margin with ochreous pubescence, leaving only an anchor-shaped black area; cheeks and front densely covered with pubescence; antennæ red, dusky above, especially the hind margins of joints; pleura with no bare patch. The mandibles, labrum, lower margin of clypeus and apex of abdomen are red, as in *T. callopus.* The black transverse band on first abdominal segment is completely isolated by dense ochreous pubescence; the black on second segment forms a very acute angle at sides. The last ventral segment is turned down at end.

Habitat: Claremont, Calif. (Pomona coll. 155). Certainly very near to *T. callopus,* but quite distinct by the characters indicated. Collected by Baker.

Triepeolus callopus Ckll.

One of each sex comes from Claremont (*Baker;* Pomona coll. 157, 158). The male is new. I give new descriptions, based on these specimens.

♀ Length about 7.5 mm.; black, with clear red legs (but spurs of middle and hind legs black); clypeus, labrum, mandibles (except apex), tubercles, tegulæ (except hyaline margin) and apex of abdo-

men also red; light markings dorsally pale creamy, ventrally white; head broad; clypeus minutely granular; antennæ red strongly suffused with blackish, apex of scape and base of flagellum brighter red; third joint shorter than fourth; front and vertex more or less striate; mesothorax very densely and minutely punctured, with two parallel bands of pale ochreous hair, a spot of hair at each posterior corner, and a band in scutello-mesothoracic suture; pleura with a large bare densely punctured patch; scutellum rather strongly bilobed; axillar teeth very short; wings somewhat dusky, brownish; abdomen with broad, continuous light ochreous bands on segments 1 to 4, that on first notched in middle anteriorly; black area on first segment a broad transverse band; light band on second segment with a large oblique lobe (directed mesad) laterally, giving the outline of a scythe; modified apical patch rounded; last ventral segment curved downward at end.

♂ Clypeus all black; scape black; flagellum dusky reddish, without any bright red; face with dense white hair; tubercles black; pleura with a bare patch just below wings, but the lower bare patch small and indistinct; femora black, with red knees; hind margins of second and following abdominal segments brownish; apical plate extremely narrow.

Crustacea From Laguna Beach

The following notes are on Crustacea collected by general and special students during the past several years. In cases where the forms were especially valuable or rare the name of the collector is indicated. Most of the specimens here recorded were collected during the past two years, a few earlier ones are also included in this report. Those marked U.S.M. were determined for us by the United States National Museum at Washington. The photographs are by Robbins, drawings by Baillard and Macdonald.

Callianassa longimana Stimp.

These "ghost shrimps" are fairly common under stones in tide pools. The median prominence of the front subacute, cornea behind middle of eye stalk. Cheliped of male elongate. Carpus nearly twice as long as broad (Fig. 14).

C. californiensis Dana, U.S.M.

Similar to the other species in general, but the exact distribution of each not yet determined. Specimens of this species were taken at Balboa bay by Mr. Daniels. These showed red in the center of the body and yellow at the sides due to the internal organs showing through. According to Rathbun there are the following differences from the other species: "Median prominence of front rounded; cornea in middle of eye-stalk; large cheliped of male very broad, the carpus very little longer than broad, but longer than palm." Those we have found are smaller than the large of the other species.

Pagurus hirsutiusculus Dana, U.S.M.

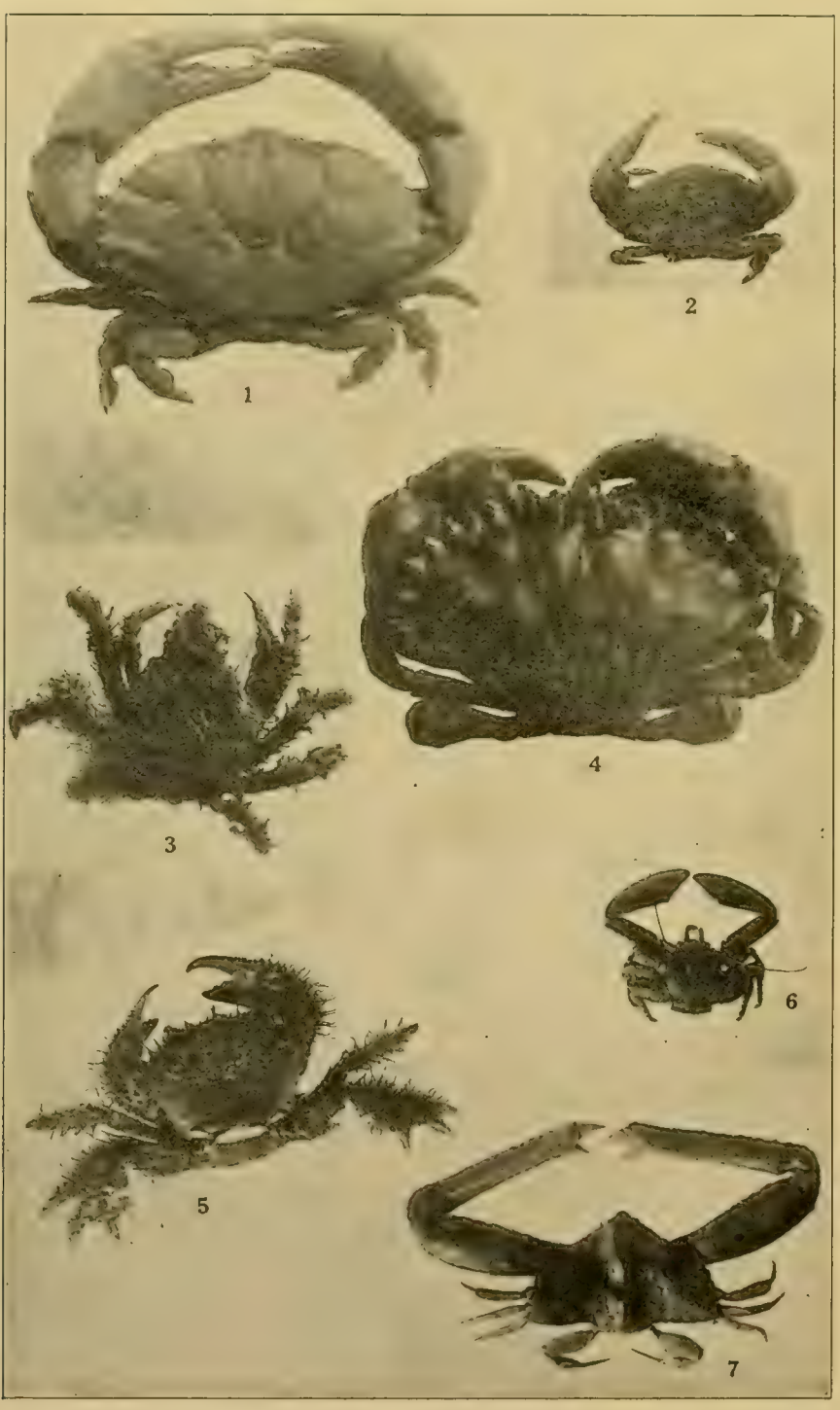
This small hermit crab was found in the tide pools. It was collected by La Follette, Macdonald, Hilton and others. Speckled and banded legs.

P. samuelis Stimp., U.S.M.

This small hermit crab was found abundantly in the tide pools. Specimens were larger than the other species as a rule. Blue legs.

Paguristes bakeri Holmes, U.S.M.

This large hermit crab was dredged off the coast of Laguna Beach by Prof. A. M. Bean and W. F. Hamilton. It was found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living in several of the larger shells such as those of *Trophon triangulatus* Cpr and T. *belcheri* Hds. (Figs. 11 and 12).

Lepidopa myops Stimp.

We have but one specimen of this sand crab collected by L. Gardner several years ago.

Blepharipoda occidentalis Randall

Numbers of these large sand crabs much like the last in general appearance were taken at all times on sandy shores.

Emerita analoga Stimp.

This is the smaller very common sand crab.

Panulirus interruptus Randall

Young of the "lobster" were often found in tide pools.

Alpheus (*Cragon*) *dentipes* Guerin

These have been taken in sponge masses and in holdfasts. These interesting little snapping shrimps were collected a number of times especially during the last summer. When placed in aquarium jars they snapped the claws in such a manner as to make one believe the jars were cracking. The left claw open and closed is shown in Fig. 19 from Miss Macdonald's drawing.

Cragon nigromaculatus Sm

Translucent white, with small black dots, a larger dark spot on either side near the caudal end of the body. Found commonly in sandy tide pools.

Betæus longidactylus Lock., U.S.M.

This is the most common lobster-like species found in the tide pools. It is of a uniform dark red brown.

B. harfordi Kingsley, U.S.M.

Found in kelp holdfasts. Pale olive green, eggs translucent green. Stout, Stafford, La Follette and others.

Spirontocaris palpator Osen

Antennal scale longer than the telson, maxilliped without exopod. Rostrum with superior margin not strongly convex, but nearly


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straight over the eyes. Rostrum not reaching the second segment of the antennular peduncle. Rostrum reaching as far as or beyond the cornea. Upper and lower limbs of rostrum not both convex. Almost transparent, red on the thorax. Kelp holdfasts from deep water.

S. picta Stimp., U.S.M.

Antennal peduncle reaching the end of the antennular peduncle. Upper margin of the rostrum straight, reaching beyond the middle of the antennal scale. Greenish with oblique reddish marks.

S. taylori Stimp.

Rostrum not reaching as far as the cornea. Collected several years ago Baker and Metz.

Hippolysmata californica Stimp.

Irregular nearly longitudinal red stripes. These are found quite abundantly in the tide pools.

Palæmonetes hiltoni Schmitt (MSS) U.S.M.

These probably occur off Laguna beach although the specimens described by Schmitt were collected Stout and Stafford at San Pedro.

BRACHYURA

Randallia ornata Randall

These beautiful crabs usually came to us from deeper water, but one was obtained from Balboa bay (Fig. 8).

Epialtus productus Randall, U.S.M.

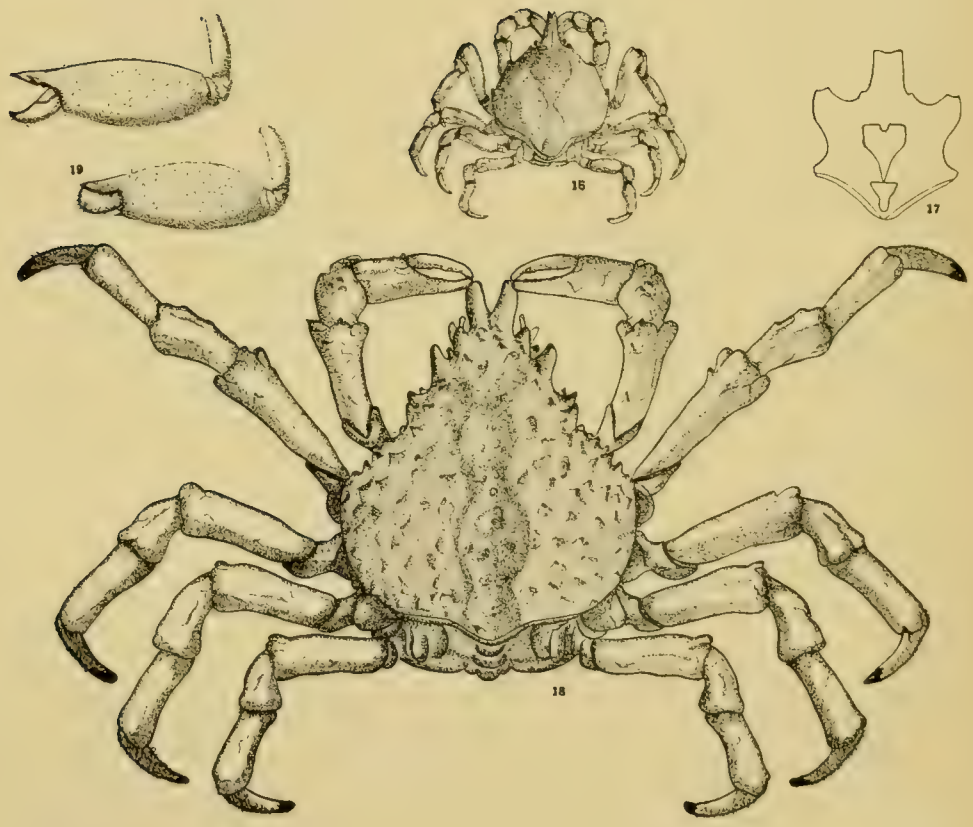
The common kelp crab was found at all times (Fig. 16).

E. nuttallii Randall, U.S.M.

This was the largest kelp crab which we obtained. Fig. 9 is from a smaller specimen than that sent to Washington.

E. bituberculatus Milne Edw. *forma minima* Lockington, U.S.M.

Only one specimen collected at low tide by Hilton. Fig. 17, redrawn from Miss Ballard's color drawing, shows the position of the lighter spots on the dorsal surface.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Loxorhynchus grandis Stimp.

A number of these large deep water forms come in every year. Fig. 18 is from Miss Ballard's drawing of a fairly perfect specimen.

L. crispatus Stimp.

One specimen of this moss crab was dredged just off shore by Prof. A. M. Bean and W. F. Hamilton (Fig. 3).

Cycloxanthops novemdentatus Lock, U.S.M.

Fig. 2 of a small one. Fig. 1 larger. These rather large crabs with the dark tipped claws were sometimes taken inshore at low tide.

Cancer antennarius Stimp. Fig 4. U.S.M.

Found under the same conditions as the one just mentioned.

Pilumnus spinohirsutus Lock.

One poorly preserved specimen we took to be this species (Fig. 5).

Heterocrypta occidentalis Dana

Our specimen is from Hermosa Beach. Others have been reported from San Diego. We may yet find it at Laguna (Fig. 7).

Pachygrapsus crassipes Randall

The shore crab is found in great abundance on any rocky shore or in the nearer tide pools (Fig. 10).

Lophopanopeus heathii Rath., U.S.M.

The young of these were often found in masses of Polyzea under rock ledges. A young male was marked as follows: white claws with dark tips, last legs white, other legs and body dark red. A young female had red claws, hind legs white, body darker. Another young male was white.

L. leucomanus Lock.

Adults of these found under stones measured 14 mm. across. Young were found under rock ledges among algæ and polyzoans. Young were found with red claws and a red mouth region.

Dasygyius tuberculatus Lock., U.S.M.

The hydroids on the Balboa piles were swarming with these peculiar spider-like crabs (Fig. 13).

Pachycheles rudis Stimp., U.S.M.

This little crab is found most abundantly in the cavities of the large white sponge.

Petrolisthes eriomerus Stimp., U.S.M.

This is a little flat crab.

P. cinctipes Randall

This has been reported from Laguna by Baker.

P. rathbunæ Schmitt (MSS), U.S.M.

This is the largest flat crab that we have found. One specimen. Hilton, 1913 (Fig. 6 somewhat reduced).

Xanthias taylori Stimp., U.S.M.

This is one of the most common of the crabs found among red sea weeds which it resembles in color and in the little knobs on the anterior parts of the appendages and body.

Herbistia parvifrons Randall, U.S.M.

Moderate sized, narrow headed flat forms. Lateral margin of rostrum not involuted. Second joint of antenna slender subcylindrical. Legs of moderate length.

Pelia clausa Rath., U.S.M.

Found hiding among sponges, polyzoans hydroids and sea weeds. Fragments cling to the animals. A young specimen had blue claws.

Scyra actifrons Dana, U.S.M.

Much as above.

Pugettia richii Dana, U.S.M.

Found much as P. clausa.

P. richii Dana, U.S.M.

Found much as the others just mentioned.

Pelia tumida Lock, U.S.M.

This was the largest decorator which we found.

During the Summer of 1913 a minute elongate crustacean was found by Hilton in Coward's cove near shore.

The U. S. M. determined this to be an immature specimen of Cyathura, of probably a new species. In November of 1915 a larger elongate specimen was secured not far from Balboa. This was also determined to be an immature specimen of the genus Cyathura.

Munidia quadrispina Benedict

A specimen of what was taken to be this species was taken from the stomach of a baracuda caught just off the coast of Laguna Beach (Fig. 15).

W. A. Hilton.

(Contribution from the Zoological Laboratory of Pomona College)

The Central Nervous System and Simple Reactions of a Rare Whip Scorpion

WILLIAM A. HILTON

A number of specimens of *Trithyreus pentapeltis* Cook were collected by the writer in the college park at Claremont. The only other record of any member of this family found in the United States is the early paper of Cook which describes this species from Palm Springs, California. At another time there will be published a description with figures of the general external anatomy of this interesting creature. Fig. 1 is partly from an outline drawing by Miss Margaret Moles. The general position of the nervous system is shown in the outline. So far as we could determine there were no sense organs but hairs. These for the most part were of the usual arthropod type, but there were several modifications of them as will be shown by Miss Moles at a later time. The hairs are most abundant under the body and are probably important organs for giving sensations from the surfaces where the animals run. The most remarkable hair sense organs are on the legs. The figure shows the position of these slender delicate structures, two on the first leg, one on the others. If an animal is approached by any object one of these hairs is apt to be touched, especially if attempts are made to seize the animal. At first it was almost impossible to believe that the little creatures did not have eyes, they so well avoided all attempts to capture them with forceps. When approached by some object which probably touches one of the long hairs they run either backwards or forwards apparently with great accuracy determining the position of the approaching object. However their backward running is most marked and most remarkable. They run with great swiftness in a backward direction in some cases for several inches. I found little evidence of other sense organs than those of touch. They did not especially avoid strong odors, but after a rather long exposure to strong light or heat they sought refuge under some object.

Although the chitin is thin in places the first attempts at serial sections through the whole body were not very successful. It was

found possible to remove the complete nervous system intact after a few trials. All figures are from such removed nervous systems. As the animals are small, being only a few millimeters in length, no branches but the chief ones could be preserved or shown in the figures. The nervous system resembles that of Thelyphorus as described by Börner, but as the animals are less complicated it is simpler. As in Börner's description there is brain or supræsophageal ganglion, a mass below the esophagus which supplies all of the thoracic region and a single abdominal ganglion. The brain or superior ganglion has but one branch on each side leading from it, this pair leads into the jaw-like first appendages. The other five pairs of branches lead off from the ventral ganglion. The first two pairs of branches come off practically at the junction of the dorsal and ventral ganglia. The connection between the dorsal and ventral parts of the head-thoracic ganglia is very broad. The cells are small and of a uniform size for the most part. They are grouped in areas as shown in methylene blue preparations from which Figs. 3 and 4 are taken. The general position of the cells is much like that in other arachnids. The central fibrous mass is quite homogeneous in the ventral ganglionic portion, but is broken into a number of partly isolated portions especially at the margins. At the very caudal end laterally there is a very characteristic lobe of fibers on each side. This lobe may represent the posterior globus of Haller although there are no smaller cells near. Other irregular masses are shown in the figures. They resemble parts of the stalks of mushroom bodies. In the cephalic dorso-lateral regions there are two conspicuous groups of cells located below the main mass of cells and separated somewhat from each other, prominent fibers connect these areas with lower levels. These may represent the anterior globuli described by Haller, 1912, but these are of larger instead of composed of smaller cells. I have found nothing like them in arachnids. They may be something like the mushroom bodies of insects.

SUMMARY

1. *Trithyreus* has no sense organs but sensory hairs, so far as could be determined.

2. The central nervous system resembles that of a spider quite closely, but the thoracic ganglion is more elongate and there is an abdominal ganglion.

3. The brain is complicated, but few long tracts of fibers are evident.

4. There may be areas which may represent anterior and posterior pairs of globuli of spiders and scorpions, but if so they do not have the same structure.

5. There are no trachea in the central nervous system.

6. The cells are uniform except for a mass each side of the brain in a cephalic dorsal position.

7. This dorso-lateral group of cells strongly suggests a special higher center. Longer fibers were seen in connection with it than with any other part.

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(Contribution from the Zoological Laboratory of Pomona College)

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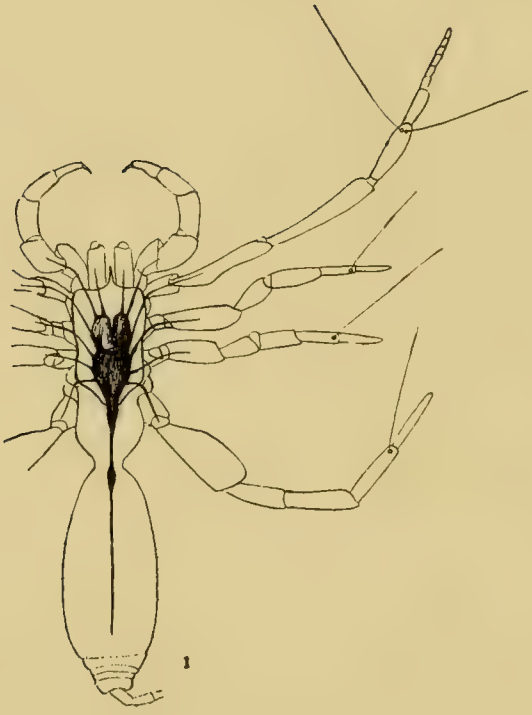


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A Rare Fish From Laguna Beach

A photograph of this fish was sent to Prof. Gilbert to whom we are indebted for the identification. The specimen was caught on a hook and line not far from the laboratory. It was brought in by Prof. A. M. Bean. No one in Laguna had ever seen anything like it and no one would venture an opinion as to what it was.

Alepisaurus æsculapius Bean

Color, dark slaty gray above, sides silvery and irridescent, back steel blue reflections. Under parts a lighter gray silvery. Adipose, pectoral and caudal fins nearly black. Skin smooth, apparently without scales.

Total length 101 cm. Length of head from tip of mouth to the back of the operculum 17 cm. Pectoral fin just back of operculum, beginning of the dorsal just over it. Length of snout to front of eye 6.6 cm. Eye 3.5 cm. long by 2.8 high. Breadth of pectoral at base 2.8 cm. Fin rays of pectorals at base 14 in number, the first and last are small, all the others branched. The first branch of the 4th to the 13th is branched again. The fifth ray with its branches is the longest, those on either side are quite long, so that the fin ends in one or several long streamers. Greatest length of fin 16.5 cm.

Distance between back of fore fin and front of pelvic 19.2 cm. Pelvic fins 8 rays, first and last not branched, membrans as on all fins delicate and easily broken. Length of fin 5.7 cm. Anal opening 3 cm. from back of anal fins, ½ cm. long, not quite so wide. Distance from pectoral to anal fin 30 cm. Length of anal 10.8 cm. 17 fin rays all branched but first and last, the first branch of each branched again. Longest part of fin (slantingly taken) 8 cm., one to the 6th fin rays nearly as long.

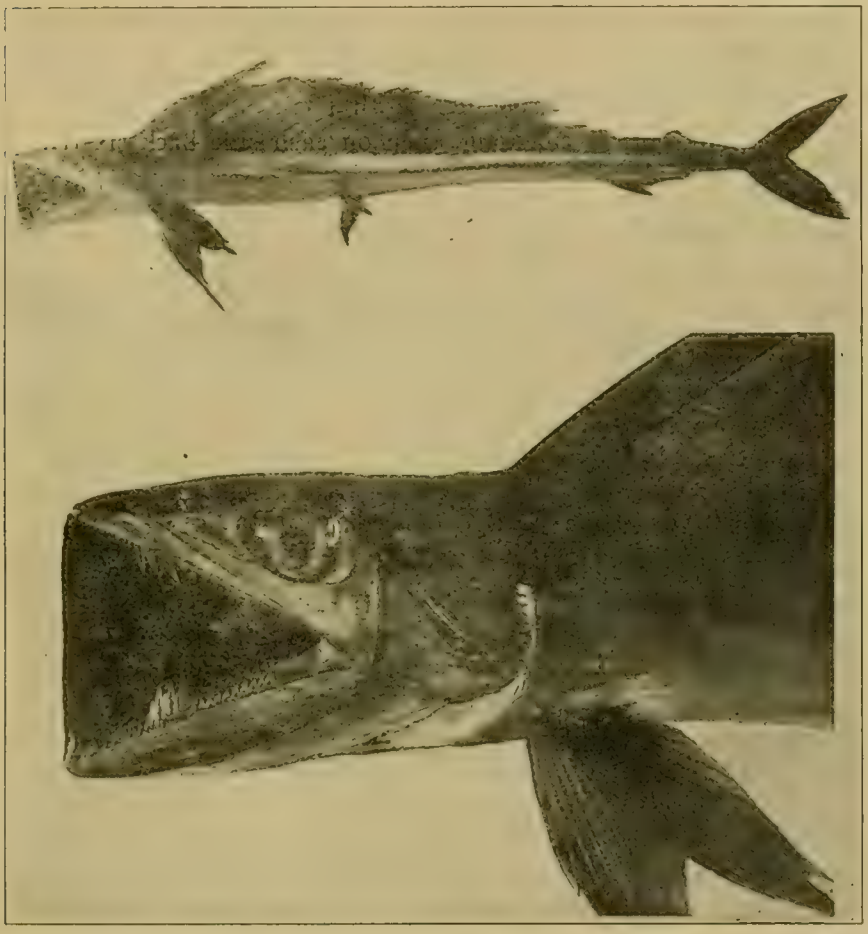
Tail symmetrical short rays in center, about 2 cm. long, at outer margin longest about 14 cm., about 40 fin rays in the tail.

Dorsal fin about 58 cm. long, 34 fin rays unbranched. Most of the fin rays are long, 10 to 19 cm. Height of the fin through most of its distance 9 cm.

Adipose fin 7.5 cm. from the dorsal at its base, ½ cm. broad at its attachment, length 3 cm.

Side and ventral region of the head:

Length of the mouth opening, 11.5 cm. Slit of gular fold, 6.5 cm. from tip of lower jaw. Gular slit to end of operculum, 10 cm.



Head narrow at level of the eyes; above it is 3.2 cm. Head at widest above is 3.5 cm. at the level of the eyes; back of this it is hardly more than 2 cm. Tip of jaw above, .5 cm. Tip of snout to nostril, 3.5 cm. Nostril, .5 cm. in diameter. Distance from nostril to eye, 2.8 cm. Whe nthe mouth is closed the lower jaw projects a

little. The lower jaw has two short, sharp teeth in front when the mouth is closed. When it is open there is a large tooth, .8 cm. long. The lower jaw hsa, next, ten teeth 1 cm. long, then three large ones 3 cm. long, then ten trinagular teeth 1 cm. long. The upper jaw has an outer row which may be seen when the mouth is closed. These are 1 cm. or less in length and 75 on a side. The roof of the mouth has three projecting teeth like the large ones below, knife-shaped, flattened from side to side, 3 cm. long. Back farther, on each side, is a similar tooth 1 cm. long, then on each side a similar tooth 1 cm. long, then on each side back six triangular teeth 3 mm. long.

The three large central teeth should really be counted four, because there is another of the same sort not yet fully broken through the membrane of the mouth.

Greatest depth of the head is 8 cm. The body was much shrunken after preservation, but the proportionate depth at various regions is well shown in the photograph which was taken by our photographer, E. M. Robbins.

W. A. Hilton.

(Contribution from the Zoological Laboratory of Pomona College)

An Unnamed Butterfly From San Francisco

BY FORDYCE GRINNELL, JR.

Rusticus acmon cottlei, new sub-species.

♂ expands 26 mm. ♀ 26-30 mm.

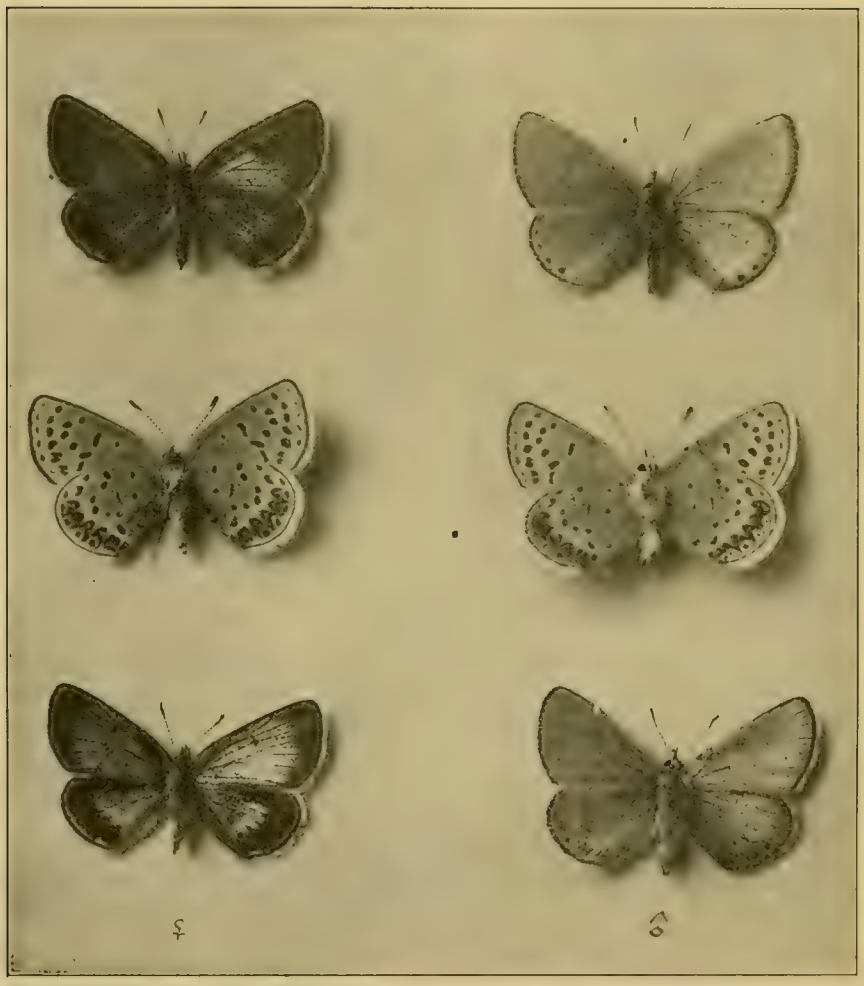
♀, forewings, upperside. An intense purplish-blue, clearly defined in most specimens; a black discal spot; a broad, black border averaging 2.5 mm. in width, wider on the costal margin, clearly defined and not merging into the ground color in most specimens, in others this black border merges into the ground color between the apex and discal spot. Fringes white, and inside a distinct black line. Hind-wings, upperside: Purplish-blue, with usual red marginal border, wide, and of an intense color, the enclosed series of black dots comparatively small. Underside: General ground color dark ashy, with the usual markings very well defined.

♂, upperside: Brilliant violet-blue, with the usual black border and white fringe; hind-wings, with a light-reddish border, very much reduced in size and intensity of color from the usual form of *acmon.* Undersides: Dark ashy, with the usual markings well defined.

Habitat: Baker's Beach, north of the Cliff House, within the city and county of San Francisco; collected during March, 1915, by Mr. James E. Cottle of that city. Types 1 ♂, 1 ♀, in the collection of the author.

This geographical race, restricted to Baker's Beach, San Francisco, can be compared with the spring form of *acmon* from other parts of California, and even from the opposite side of San Francisco bay at Niles Cañon, to which it is somewhat closely related. It can be distinguished, however, especially with the females, by the intensity, sharpness and distinctness of the deep purplish blue, the heavy black border; the greatly extended deep red border of the hind-wings; and darker ashy gray and distinct markings of the undersides.

It is in the same category as the other blue butterflies of the San Francisco region: *Xerxes, pheres, mertila, antiacis* and *behrii,* which



have assumed a distinct *facies,* due, undoubtedly, to the peculiar isolation and meteorologic conditions of that region. It was the intention of the late Beverly Letcher to describe and name this form.

It gives me great pleasure to name this local form in honor of my friend, Mr. James Edward Cottle of San Francisco, well known as a collector of the Lepidoptera around Mt. Shasta and San Francisco bay, and the care displayed in the preparation of his captures. Not less is his personality at entomological meetings; and it was himself who pointed out to me the distinctive points, the desirability of naming it, and presented several specimens to me, and supplied the accompanying photograph, and who will be pleased to defend the naming of it against any criticism.

Caprellidæ From Laguna Beach

M. SHAW

Caprella tuberculata n. sp.

The peræon is covered with blunt tubercles, placed in the following positions: Two on the second body segment, one near the center, the other in line with it and posterior. Five on the third segment, one small pair anteriorly situated, another larger pair near the center, one single large one posteriorly situated. Four on the fourth segment: a small pair anteriorly situated, a single large one in center, and a single large one posteriorly situated. Six on the fifth segment: one small pair anteriorly situated, three forming a triangle near the center, and one large one posteriorly situated.

Two fairly large ones on the sixth segment. Also the same on the seventh segment. The peræon has small spines on each side. There are seven tubercles on the ventral side: two on fifth segment, two on the fourth and three on the third.

There are two sharp spines on the first segment: one posteriorly situated, the other on the left, a third of the way down the segment.

The first segment is triangular in shape, shorter than the second. The second and third the same length, the second being broader than the third. The fourth slightly longer than the second and third. The fifth, sixth and seventh each growing smaller, respectively, and truncate at the tip. The branchia ovate in shape. Antennæ stout, superior pair 3 mm. in length. First joint stout and

thick, not as long as second. Third shorter than the first. Flagellum nearly as long as peduncle, having from 10 to 12 joints. Inferior pair of antennæ extending a little past middle of the flagellum of superior.

The first gnathopod attached far forward and small, finger slender, three-fourths as long as hand. One spine near the base of hand, the finger is finely toothed along the inner margin.

The second gnathopod is attached to the middle of the body segment. The basal joint is short and thick. The finger is three-fourths the length of palm and has fine teeth along inner margin. The palm is slightly concave, having one large, sharp tooth at the base, also a small tooth at distal extremity.

Third, fourth, and fifth peræopods similar in structure, armed with stout hairs; palm slightly concave.

Length of specimen, 10-12 mm.

Color, translucent.

Specimens taken at Laguna Beach by Dr. W. A. Hilton, August, 1915, from polyzoa at Abalone Point. Type in Pomona College collection.

Dr. Hilton found another lot of specimens of this genus living among the hydroids at Balboa Bay. It may be a new species, as it differs from any descriptions we have found, but it may simply be a variety of *Caprella geometrica* Say, at least we will not describe it further at this time.

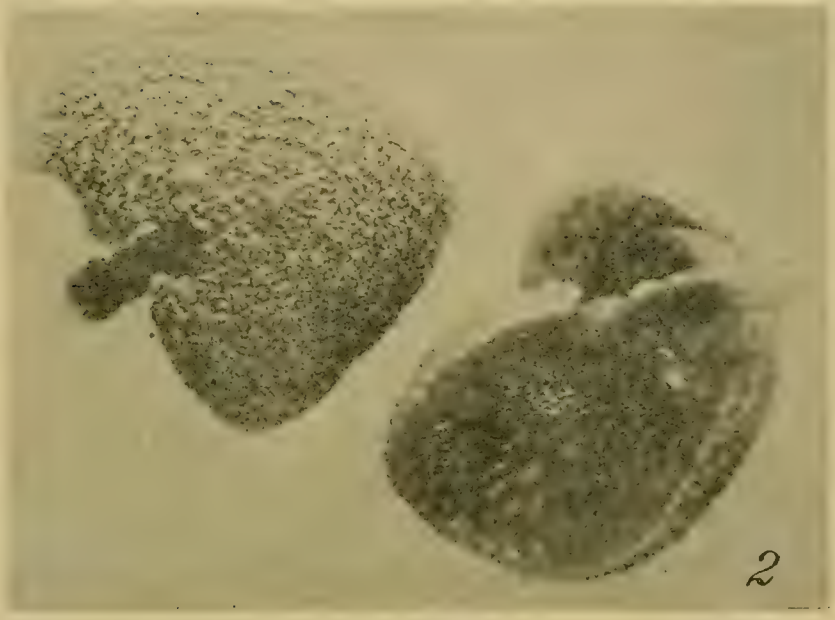
(Contribution from the Zoological Laboratory of Pomona College)

Notes on Coelenterates and Echinoderms From Laguna Beach

The following notes relate to specimens obtained by various students and others in the general region of Laguna Beach during the past year. We have Prof. H. B. Torrey to thank for the general determinations of the first three, the first two from specimens, the third from a photograph. We also wish to thank A. L. Barrows for the verification of certain necessary literature references. All the photographs but one are by Robbins:

Velella septentrionalis Eschscholtz.

Large numbers of these came in during the winter of 1914. Miss P. E. Jahraus preserved a number of fine specimens for the laboratory. They kept their colors in formalin for mone than a year. (Figs. 3 and 7.)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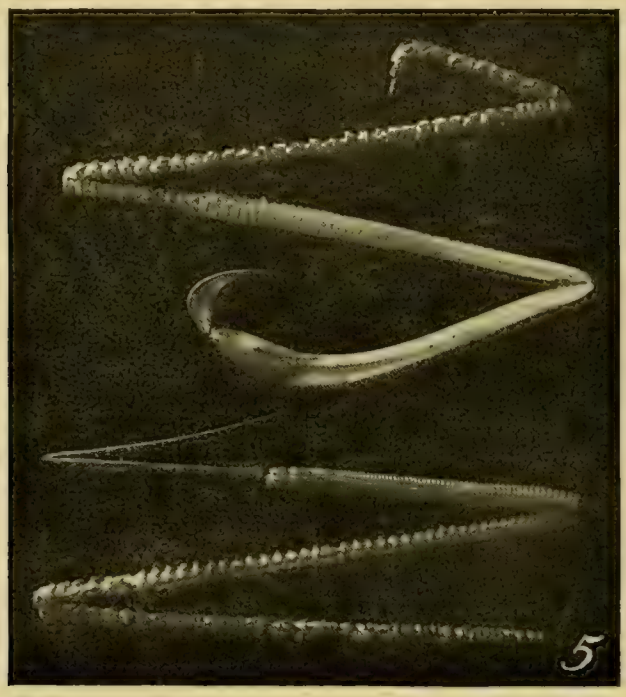
Stylatula gracilis Verrill.

A number of these slender specimens were collected from the shallow waters of Balboa Bay, where they were quite abundant. (Fig. 5.)



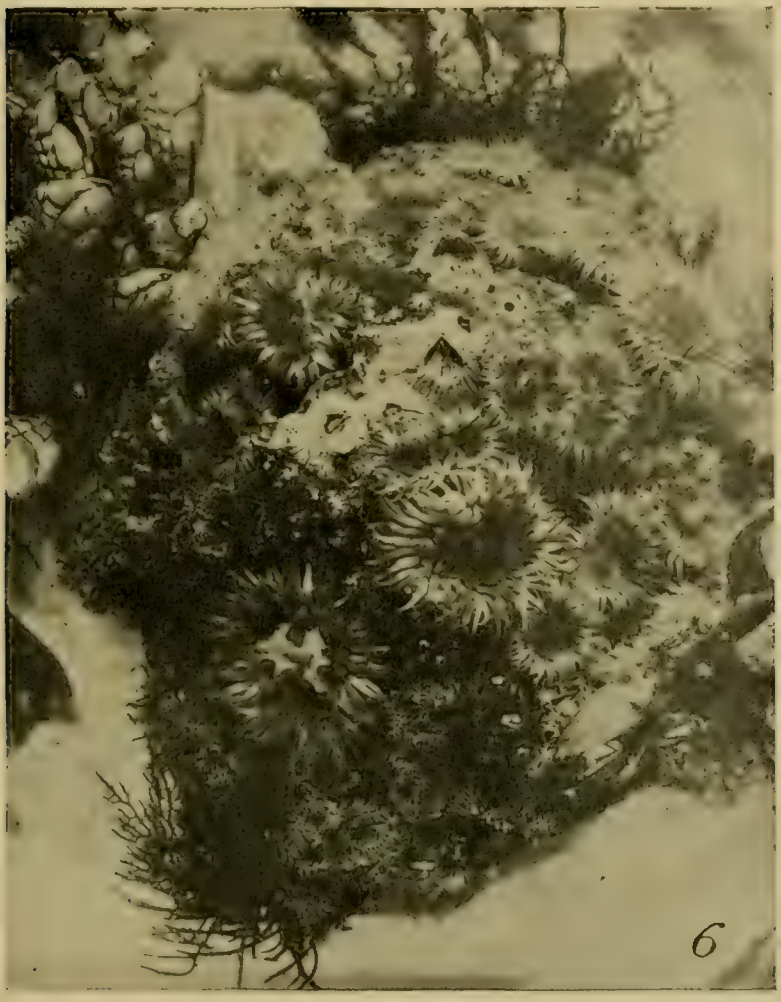
Metridium dianthus Ellis.

A fine specimen of this species was brought in by a fisherman from about a 500-foot depth. The fish-hook had caught on its side and the animal did not live many days. It was attached to a chunk of rock with some coral skeletons. This rock fragment to which it clung weighed about ten pounds. Photograph 1-5 natural size. (Fig. 1.)

Bunodactis xanthogrammica Brandt.

These common anemones are abundant on almost every bit of rocky shore. They differ greatly in size and coloration. Many of

those inshore and often uncovered at low tide have bits of rock or shell fragments clinging to them, apparently for protection against crabs and possibly other enemies. These smaller inshore specimens



are usually of a light-brown color. Larger individuals are found in the deeper tide pools, where they are always covered with water. These, as a rule, do not have stones attached to them. The common shore crabs often retreat under the outspread tentacles of these

large individuals. The colors and markings of these are quite variable. Sometimes individuals have a decided blue tinge. Some are quite green. Below Aliso Canyon a beautiful deep-green specimen was found, which was nearly a foot in diameter. Photograph by Miss Clency. (Fig. 6.)

Renilla amesthystina Verrill.

Many specimens of this beautiful sea pansy were dredged just offshore from Emerald Bay. Other specimens were obtained at other places within a mile or more. These were very satisfactory specimens for the aquarium. (Fig. 2.)

Of the two following echinoderms, the first is very common, the other we have not taken before.

Dendraster excentricus Eschscholtz.

Large numbers of these were dredged off Emerald Bay and other places not for from Laguna Beach. (Fig. 4.)

Fig. 8.

Ludia foliata Grube.

A single specimen of this species was dredged by Prof. A. M. Bean off the coast of Laguna Beach. (Fig. 8.)

W. A. Hilton.

(Contribution from the Zoological Laboratory of Pomona College)

Lima Dehiscens at Laguna Beach

MARGARET L. CATE

This interesting mollusk was obtained several times during the Summer of 1915. Its activities were observed in the aquarium. It usually remained in an expanded condition. Its movements were caused by forcing water out of the siphons not like the movements of Pecten. The reproduction of the drawing given at this time is not quite the right color of pink.

(Contribution from the Zoological Laboratory of Pomona College)

Lima dehiscens Conr.

The Genus Vanessa in California

E. O. Essig, *University of California, Berkeley, Cal.*

(Lepidoptera)

The California species of *Vanessa* are interesting because of the world distribution of two of the four species, as well as because of the very great numbers of at least two species which are almost always to be encountered in the state. The four species are: The red admiral, *Vanessa atlanta* (Linn.), the painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.), the west coast lady, *Vanessa carye* (Hübn.)[1] and the painted lady or thistle butterfly, *Vanessa cardui* (Linn.). Another interesting fact is that all of these species have more or less distinct color phases. One of these phases has been described by Letcher[2] as a variety, *Vanessa carye muelleri,* a short description and illustration of which is also included. Of the above species, *Vanessa cardui* (Linn.), is by far the most abundant in the state; *Vanessa carye* (Hübn.) is next, and ordinariy not far behind, especially in the northern and central parts, particularly along the coast; *Vanessa atlanta* (Linn.) is the next, with much fewer numbers, and last of all, and by far the least often taken, is *Vanessa huntera* (Fab.), though this species is by no means rare.

Key to Species—Adults.

The butterflies may be easily separated by the following key:

1. Front wings black with a single reddish or tawny transverse stripe (Fig. 1).....*Vanessa atlanta* (Linn.)
   Front wings mottled black, reddish and tawny.....2
2. Eye-spots on under sides of hind wings represented by white spots only (Fig. 9).....*Vanessa carye muelleri* (Letcher)
   Eye-spots on under sides of hind wings distinct.....3
3. Two large eye-spots on under side of each hind wing (Fig. 2).....*Vanessa huntera* (Fab.)
   Four or five eye-spots on under side of each hind wing.....4

[1] The specific name of this butterfly is often incorrectly spelled *caryæ.*
[2] Ent. News, Vol. IX, p. 38, 1898.

4. Apices of front wings truncate; black band across middle cell of front wings continuous (Fig. 8).....*Vanessa carye* (Hübn.)
Apices of front wings rounded; black band across middle cell of front wings broken (Fig. 10).....*Vanessa cardui* (Linn.)

The Red Admiral.

Vanessa atlanta (Linnæus)

Papilio atlanta Linnæus, Syst. Nat., Ed. 10, p. 478, 1758.
Pyrameis atlanta Hübner, Verz. Eur. Schmett, 2, 1816.

(Fig. 1)

This is a widely distributed species, ranging throughout North America, Europe, Northern Africa and Northern Asia, but is not as abundant in California as *V. carye* (Hübn.) and *V. cardui* (Linn.). It occurs, however, in sufficient numbers to be taken generally throughout the state.

The young caterpillars vary from pale-yellow to brown, and when full grown may become darker, with often a purplish hue. In the mature forms the bodies are more or less covered with minute whitish specks and on each side there is a row of yellow spots which appear as a continuous yellow line. The branching spines are black or whitish and the head jet-black, covered with white tubercles. The length averages 1½ inches. The caterpillars are more or less gregarious in habit and construct nests by drawing together the opposite sides of the leaves, parts or nearly all of which may be eventually devoured.

The chrysalids are light- or dark-brown and are often covered with a grayish bloom. The tubercles on the back are golden.

The butterflies (Fig. 1) have a wing expanse of from 2 to 2¼ inches and the bodies vary from ⅞ to 1 inch in length. The entire upper surface of the wings and body is velvety dark-brown or black. There is a conspicuous red or orange-colored oblique stripe across the middle of each front wing and a wide border of the same color along the outer margin of each hind wing. Along the entire margin of the wings is a row of narrow white spots. There is also a row of five white spots, three small and two much larger, near the apex of each front wing, and a larger rectangular white spot

touching the costal margin midway between the row and the reddish oblique stripe. In each reddish area of the hind wings is centrally located a row of small black spots. An angular purple area occurs at each anal angle. The ventral surface is beautifully marked and marbled with many colors. The reddish stripe so conspicuous across the upper sides of the front wings shows even more brilliantly beneath. All of the white spots also show on the under side. The marbled effect is made up of dark-gray, bright-blue, purple and black. A row of five eye-spots shows distinctly on each hind wing, which do not contrast greatly with the dark background. The body has a bluish or purplish iridescence above and is thickly covered with light-brown hairs beneath. The antennal joints are alternately white and black, the knobs being black with yellow tips. The palpi and legs are dark above and light-brown beneath.

Like the other species, this insect appears to breed almost continuously throughout the year in California, so that it is very difficult to mark the number of broods. In the high altitudes there are probably but two generations, as in the Eastern states.

The caterpillars feed on hops, nettle, false nettle and pellitory.

THE PAINTED BEAUTY OR HUNTER'S BUTTERFLY

Vanessa huntera (Fabricius)

Papilio huntera Fabricius, Syst. Ent., p. 499, 1775.

Pyrameis huntera Doubl.-Hewits., Gen. Dirun. Lep., p. 205, 1850.

(Fig. 2.)

This species is not as abundant in California as the others, and is to some extent a mountain flyer, especially in the southern part of the state, but it is not a rare species throughout California. It ranges from Nova Scotia on the north to Central America on the south, and may be truly called a North American species, being one of the two species in California which are confined to this hemisphere.

The young caterpillars are dull reddish-brown with black heads and black branched body spines. When full grown they are grayish-black with yellow or greenish bands around the bodies. A few faint

longitudinal lines cross the yellow bands and disappear in the black areas between. There are two yellow lines on the sides, the upper one marked with an orange spot immediately above each spiracle. There is a white spot on each side of the dorsal line on the middle segments. The head is black and covered with brown hairs, the under side being sprinkled with small white or yellow specks. The true legs are black and the prolegs purplish-brown[3]. The larvæ may be found scattered over the food plants and make nests by drawing together the leaves, bits of stems and other fragments of the plants, leaving but a small exit and entrance hole.

The chrysalids are yellowish or light-brown and irregularly marked with large golden blotches.

The butterflies have a wing expanse averaging about 2 inches and a body length of about ⅝ of an inch. The upper surface of the wings is reddish-brown or tawny with numerous black and white markings, as shown in Fig. 2. The number and arrangement of the white spots on the front wings are not greatly different from the preceding species, excepting that the outer row has four instead of five, and arranged in the form of a crescent. The larger somewhat rectangular-shaped spot on the costal margin is more often yellow or tawny than white. Near the apical margins of the front wings are two purple lines and two shorter ones of the same color near the anal angles. The under surface is not so brightly colored as the upper surface, and, with the exception of the tawny or rosy area near the middle of the front wings, consists of a mixture of pale-browns and grays, with a faint purplish line extending along the outer margins of both pairs of wings. The most conspicuous markings are the two large eye-spots on the under side of each hind wing, which readily separates the species from the others. The body is dark-brown above with greenish iridescence and thickly beset with brownish hairs. The ventral surface is pale-gray. The palpi and legs are brown above and light-gray beneath.

The caterpillars feed upon the following plants: common or plumed thistles (*Cnicus* spp.), plumeless thistles (*Carduus* spp.), nettle, burdock, cotton or Scotch thistle (*Onopordon acanthium* Linn.), hollyhock, sunflower, mallow, milk thistle (*Silybum mari-*

[3] Middleton, Miss Nettie, 10th Rep. Ent. Ill., p. 86, 1881.

anum Gærtn.), *Senecio cineraria* DC., cudweed, everlasting *(Antennaria plantaginifolia* Rich.), blue-weed *(Echium vulgare* Linn.) and scorpion grass or forget-me-not *(Myosotis* sp.).

THE WEST COAST LADY.

Vanessa carye (Hübner)

Hamadryas (Decora) carye Hübner, Verz. Eur. Schmett., 33, 1816.

Pyrameis carye Doubl.-Hewits., Gen. Diur. Lep., p. 205, 1850.

(Fig. 3-8.)

As the common name implies, this is strictly a west coast species, ranging from British Columbia to Chile and as far east as the Rocky Mountains. It is very common in California, being exceedingly abundant in the central and northern sections along the coast, though it is very plentiful in the southern part as well. It does not, however, occur in such great flights or migrations as does *Vanessa cardui* (Linn.).

The writer has had this species under careful and constant observation for more than a year and has been able to secure all stages in quantities and to prepare descriptions of them from the local material.

The eggs (Fig. 3) are rich dark-green, exceedingly small, somewhat barrel-shaped and with prominent narrow longitudinal ridges, as shown in the illustration. They are fastened singly to the leaves, stems, webs of the caterpillars and other places. The first eggs observed were laid during June and the succeeding months until the present date (Feb. 1), and in all probability they may be found during almost the entire year.

The young caterpillars (Fig. 4) are almost entirely black above with brownish or amber under-surface. Some individuals are light-gray or yellowish instead of black, and form a distinct color phase. The dark individuals have yellowish-green markings and the light phase is marked with numerous small black specks. The full-grown caterpillars (Fig. 4) also have two color phases like the young, but the greatest numbers are black above with bright yellowish-green markings, black branched spines and two rather indefinite broken

yellow lines on each side. The light phase is pale yellowish throughout with few or many small black specks on the dorsum; amber ventral surface and prolegs and black head and true legs. The length varies from 1½ to 2 inches.

The caterpillars are often very numerous, feeding on nearly every part of the plants. The very young ones spin but small webs over themselves near the middle of the leaves, and it is not until they are nearly half-grown that they are able to draw together and fasten the edges of the leaves and make a more roomy abode. Unlike the caterpillars of some of the other species, they remain in their nests feeding on the leaves under the webs until nearly all have been devoured, when they seek a new leaf, make another nest and begin feeding as before. The work (Fig. 5) is such as to cause the plants to appear quite ragged and unsightly, and serves to quickly detect their presence. When ready for pupation the caterpillars leave the nests and seek some more hidden and secure spots not easily found.

The chrysalids (Fig. 6) are light-gray or grayish-brown with two distinct and two much smaller silvery-white spots on the dorsum at the constriction between the thorax and the abdomen. The surface is more or less faintly, and in some distinctly, iridescent golden. The length averages about ⅝ of an inch. From a large number of chrysalids only a very small percentage developed into butterflies because of the effectual parasitism of a tachina fly, *Phorocera saundersii* Will. Many of the parasitized chrysalids could at once be told by a copious bleeding, the liquid hanging in long slender threads which became dry and brittle. It is a conservative estimate to say that at least 85 per cent. were thus destroyed.

The butterflies (Figs. 7 and 8) are much like the adults of *Vanessa huntera* (Fab.) and *Vanessa cardui* (Linn.). The presence of more than two eye-spots on the under side of each hind wing separates them from the former, and the truncate apices of the front wings or the presence of the continuous black band across the middle cell of each front wing will distinguish them from the latter. There is rarely a distinct rosy tint on the front wings instead of the tawny color. The eye-spots on the under surfaces of the hind wings are fairly distinct, consisting of four quite large and perfect ones and one smaller anterior imperfect one on each. The bodies are faintly

metallic-green above, thickly covered with brownish hairs, and the ventral surface is pearl-gray. The antennæ are light-brown with yellow-tipped knobs. The palpi and legs are brown above and light pearl-gray beneath. The wing expanse averages about 2⅛ inches and the length of the body ⅝ of an inch.

The caterpillars feed on hollyhock, mallow and tree mallow.

MUELLER'S BUTTERFLY.[4]

Vanessa carye muelleri (Letcher)

Pyrameis carye muelleri Letcher, Ent. News, Vol. IX, p. 38, 1898.

(Fig. 9.)

This variety is so differently colored that at first glance it might easily be taken for an entirely different species until one becomes accustomed to knowing it. There is a blending of the tawny and black colors and a certain segregation of them so as to form no distinct and sharp division lines. Usually, however, the tawny replaces some of the black. The large white rectangular spot on the costal margin is also sometimes replaced by the tawny and the eye-spots on the undersides of the hind wings are indicated by small indefinite white blotches. The color of the body, legs, antennæ and palpi is normal of the species. The three specimens in the collection of the University of California average a little smaller than do those of the species.

[4] Dr. E. C. Van Dyke has kindly furnished the following interesting note: "Varieties like *muelleri* Letcher, for *cardui* Linn. has a similar variety occasionally and specimens of *atlanta* Linn. and *huntera* Fab. have been seen which show a decided tendency toward the same type of markings, are in reality pathological phases which have the reddish markings extended or agglutinated at the expense of the other colors. They invariably occur during the summer or the first part of autumn and are no doubt sporadic seasonal phases produced as a result of certain mid-summer conditions. A particularly interesting thing in connection with *muelleri* Letcher is that a number of specimens occur every year, particularly in the territory back of Oakland and Berkeley, Cal., where the greatest numbers of the phase have been observed in the state. None of the specimens seen show any indication of being hybrids."

THE PAINTED LADY OR THISTLE BUTTERFLY

Vanessa cardui (Linnæus)

Papilo cardui Linnæus, Syst. Nat. 10 Ed., p. 475, 1758.
Pyrameis cardui Doubl-Hewits., Gen. Diur. Lep., p. 205, 1850.

(Figs. 10, 11.)

This is claimed to be the most widely distributed butterfly in the world, and is found in all temperate regions and often in the tropics. It is by far the most abundant species in California, being most plentiful in the southern part of the state and in the interior valleys, and less common along the coast of the central and northern parts. In the southern part of the state it often appears in great migratory flights, a number of which have been recorded, among which were those of the years 1895[5] and 1902[6]. In October, 1913, Mr. E. P. Van Duzee observed a migration at San Diego. During the summer of 1914 the writer noted great numbers in the San Joaquin Valley, which, though they did not constitute a flight, brought forth considerable comment and the occurrence was reported by Dr. Burton Evermann.[7]

The young caterpillars are dark with indefinite yellowish markings. The full-grown forms (Fig. 9) vary from gray to reddish-brown or almost black and sprinkled with minute white and yellow specks. There is a very indistinct and broken dorsal yellow stripe and a wider and more distinct line of the same color on each side. The spines are white or amber, tipped with black. Small light hairs arise from numerous whitish specks over the body. The head is dark-brown or black and thickly covered with whitish hairs and a few black tubercles. The length varies from 1¼ to 2 inches.

In making their nests the caterpillars roll the edges of the leaves and incorporate various extraneous matter which might be secured. Their work is often quite destructive and is much like that of *Vanessa carye* (Hübn.).

The chrysalids (Fig. 9) are light-brown and very beautiful, appearing as if dipped into molten gold.

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[7] Ent. News, Vol. XXV, p. 415, Nov., 1914.
[5] Farnham, Geo. D., Ent. News, Vol. VI, p. 150, 1895.
[6] Essig, E. O., Inj. and Ben. Ins. Cal. 2nd Ed. Cal. Hort. Com., p. 462, 1915.

The butterflies (Fig. 10) greatly resemble the two preceding species, and the chief differences have already been pointed out in discussing them. The presence of the rosy color on the wings is quite characteristic, though this is by no means reliable in distinguishing the species. The eye-spots on the under sides of the hind wings are very distinct, consisting of a row of four quite large ones and a smaller and less distinct anterior one on each wing. The wing expanse varies from 2 to 3 inches and the length of the body from ¾ to ⅞ of an inch. Like the other species, this insect is almost a continuous breeder in California, gradually diminishing in numbers during the winter months and becoming very plentiful during the early spring, summer and fall.

The very great numbers of the caterpillars is sometimes responsible for some damage to garden crops, but ordinarily only the native vegetation and cultivated ornamentals are consumed.

The list of food plants is quite large and probably only imperfectly known. It includes the following: Plumeless thistles *(Carduus* spp.), common or plumed thistles *(Cnicus* spp.), milk thistle *(Silybum marianum* Gærtn.), cotton or Scotch thistle *(Onopordon acanthium* Linn.), mallow, *Amsinckia* spp. *Senecio cineraria* D. C., hollyhock, sunflower, beans, burdock and nettle. In this state the *Amsinckia* spp. and the mallow *(Malva* spp.) are the preferred food plants.

FOOD PLANT INDEX.

Althaea rosea—see hollyhock.
Amsinckia spp.
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Antennaria plantaginifolia—see everlasting.
Arctium lappa—see burdock.
Beans *(Phaseolus* spp.)
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Blue-devil—see blue-weed.
Blue-weed, *Echium vulgare* (Linn.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Boehmeria cylindrica—see nettle, false.
Burdock, *Arctium lappa* (Linn.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Carduus—see thistle, plumeless.
Cat's ear—see everlasting.
Cnicus—see thistle, plumed.
Cudweed *(Gnaphalium* spp.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Echium vulgare—see blue-weed.
Everlasting, cat's ear, ladies' tobacco, pussy's toes *Antennaria plantaginifolia* (Rich.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Forget-me-not or scorpion grass *(Myosotis* sp.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Gnaphalium—see cudweed.
Groundsel *(Senecio cineraria* D. C.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Helianthus—see sunflower.
Hollyhock, *Althaea rosea* (Cav.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
West coast lady, *Vanessa carye* (Hübn.).
Hop, *humulus lupulus* (Linn.).
Red admiral, *Vanessa atlanta* (Linn.).
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Ladies' tobacco—see everlasting.
Lavatera assurgentiflora—see Mallow, tree.
Mallow *(Malva* spp.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
West coast lady, *Vanessa carye* (Hübn.).
Mallow, tree, *Lavatera assurgentiflorn* (Kell.).
West coast lady, *Vanessa carye* (Hübn.).
Malva—see mallow.
Myosotis—see forget-me-not.
Nettle *(Urtica* spp.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Red admiral, *Vanessa atlanta* (Linn.).
Nettle, false, *Boehmeria cylindrica* (Wild.).
Red admiral, *Vanessa atlanta* (Linn.).
Onopordon acanthium—see Scotch thistle.
Parietaria debilis Forst.—see Pellitory.
Pellitory, Parietaria debilis (Forst.).
Red admiral, *Vanessa atlanta* (Linn.).
Phaseolus—see beans.
Pussy's toes—see everlasting.
Scorpion grass—see forget-me-not.
Senecio cineraria—see groundsel.
Silybum marianum—see thistle, milk.
Sunflower *(Helianthus* spp.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Thistle, Argentine—see thistle, Scotch.
Thistle, asses'—see thistle, Scotch.
Thistle, blessed—see thistle, plumed.
Thistle, common—see thistle, plumed.
Thistle, down—see thistle, Scotch.
Thistle, holy—see thistle, milk.
Thistle, milk, *Silybum marianum* (Gærtn.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Thistle, oat—see thistle, Scotch.
Thistle, plumed, common or blessed *(Cnicus* spp.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).

Thistle, plumeless (*Carduus* spp.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Thistle, Queen Mary's—see thistle, Scotch.
Thistle, Scotch, Argentine, asses', down, oat, Queen Mary's, silver, *Onopordon acanthium* (Linn.).
Painted beauty or Hunter's butterfly, *Vanessa huntera* (Fab.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Thistle, Silver—see thistle, Scotch.
Urtica—see nettle.

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(Note—The author wishes to acknowledge with thanks the generous and valuable help received from Mr. E. P. Van Duzee, Prof. C. W. Woodworth and Dr. E. C. Van Dyke, all of the Department of Entomology, University of California, in preparing this paper; also to the California State Commission of Horticulture for the loan of the cut of Figures 10 and 11.)

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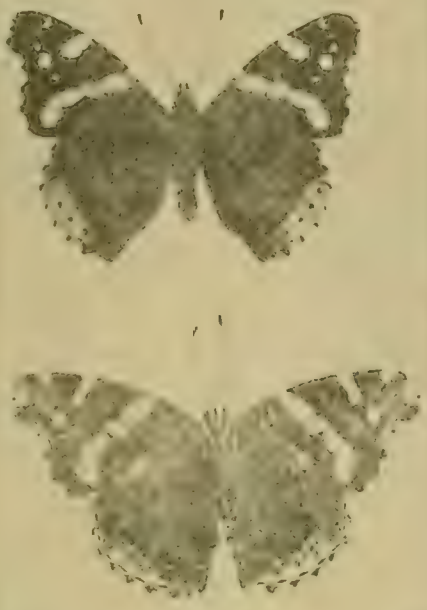
Fig. 11. The painted lady or thistle butterfly, *Vanessa cardui* (Linn.). Dorsal and lateral aspects of adults. (Author's illustration. Courtesy Cal. Hort. Com.)



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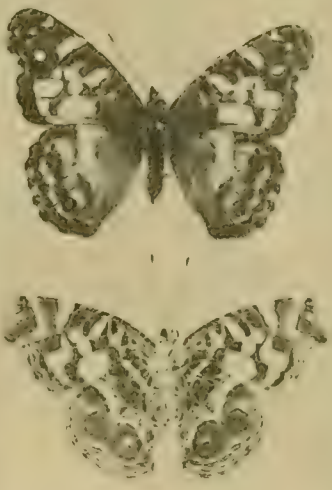

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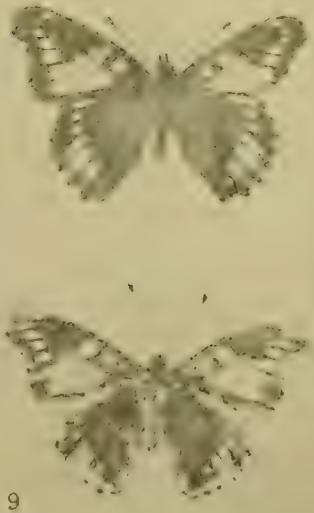

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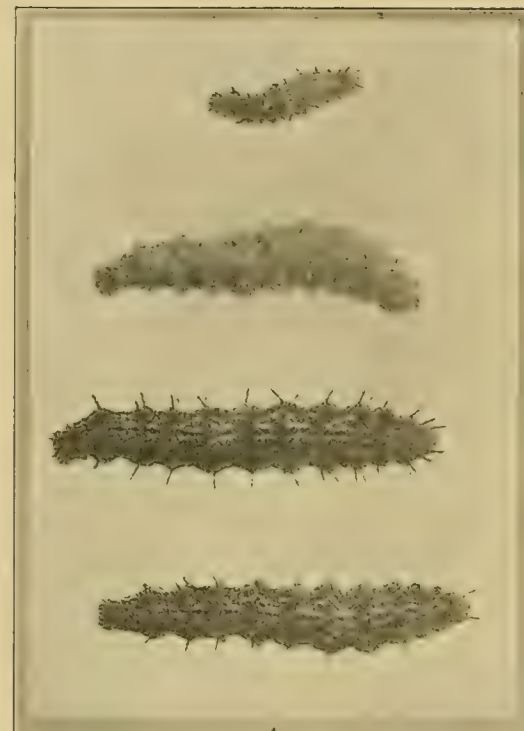

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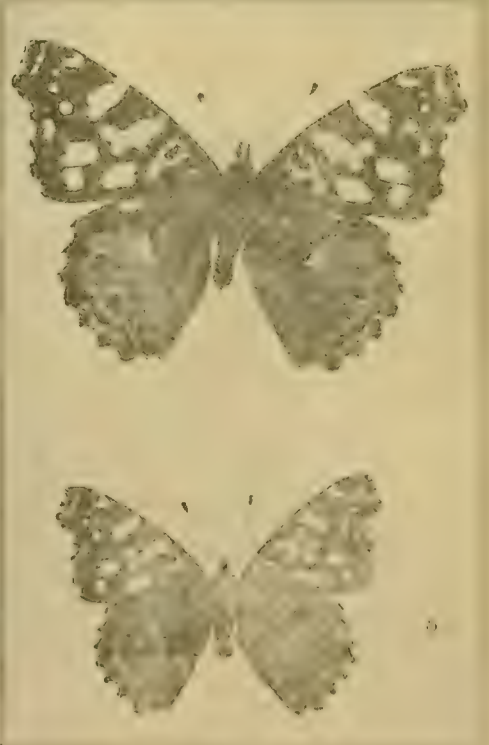

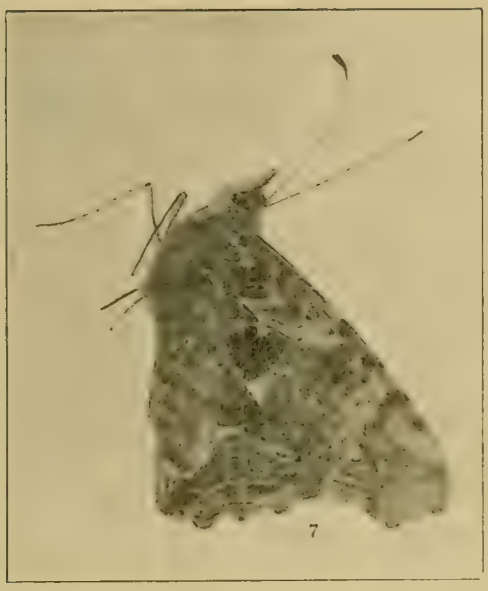

Fig. 10

Fig. 11

Crab-Spiders of the Claremont-Laguna Region

MARGARET L. MOLES

In the Claremont region, spiders belonging to the family Thomisidæ are very abundant. Though great in numbers only five genera of the family have been found. During the months of May and June they frequent the poppies and feed upon the small Hymenoptera and Diptera, which come to the flowers. A great many were found in the flowers with dead bees, showing that the spiders grabbed at the large prey resulting in the death of both. They are very wary, the instant a shadow falls on the poppy plant they run to the under side of the flower and drop to the ground. The coloring of the spiders is so protective that when they are down among the stamens of the flowers it is hard to distinguish them unless closely observed. The species that were found to frequent the poppies were *Misumena aleatoria, Misumenops asperatus* and *Xysticus californicus*. The wild flowers which have the colors blue, red or lavender were never found to be inhabited by any members of this family, but nearly all the wild flowers of a yellowish hue had from one to two thomisids in them. A great many young were found during the months of May, June and July.

Xysticus californicus, Philodromus pernix and *Xysticus gulosus* were found under the bark of tree, *Xysticus californicus* being found in the tall grass, under the bark of the eucalyptus trees and in poppies. *Philodromus pernix* and *Xysticus glusosis* were found under eucalyptus bark, oak bark and sycamore.

Misumena aleatoria was found on tar weed, poppies, in a dried-up yellow rose and in a pink rose. The one found in the drie-up yellow rose (Plate I) was remarkable in its protective coloring, looking exactly like a dried yellow rose petal in the dark brown stamens. Two variations in coloring were found in *Misumena aleatoria.* One which was found in the green grass had a brownish green body and lacked any dark spots on the abdomen, the other was a yellow color with only one dark brown spot on the abdomen, the head and

thorax showed no trace of black, there were no wrinkles on the abdomen and the legs were a light yellow green. This one was found on the honeysuckle and resembled as near as possible the coloring of the honeysuckle flower and vine. We have Dr. R. V. Chamberlin to thank for the determination of most of the specimens studied. No results of the study of color changes are given at this time.

A LIST OF CLAREMONT CRAB-SPIDERS

Misumena aleatoria (Hentz). Found on old yellow rose bushes, pink rose bushes and tar weed.

Misumenops asperatus (Hentz). Found on poppies and tar weed.

Philodromus pernix (Blackwall). Found under bark.

Xysticus californicus (Hentz). Found under bark, in grass and in poppies.

Xysticus gluosus (Key). Found under bark of eucalyptus trees, sycamore trees and oak trees.

Xysticus triguttatus (Key). Found in the grass and low bushes, Palmer's canyon.

Thanatus coloradensis (Key). Collected by Baker and listed by Banks in his article in the Proc. Acad. Nat. Sci., Phila., 1901, p. 585.

Tibellus duttonii (Hentz). Found on mustard about Claremont.

(Contribution from the Zoological Laboratory of Pomona College)

EXPLANATION OF PLATES

Plate I. *Misumena aleatoria* (Hentz). Found in yellow rose. Yellow crinkled body. Dark brown abdomen spots. Collected September, 1915.

Plate II. *Misumena aleatoria* (Hentz). Found on rose bush, in a partly dried-up rose. Collected October, 1915.

Plate III. *Misumenops asperatus* (Hentz). Found on tar weed. Hemizonia.

Plate IV. *Philodromus pernix* (Blackwall).

Plate V. *Xysticus gulous* (Key). Found on bark of sycamore.

Plate I

Plate II

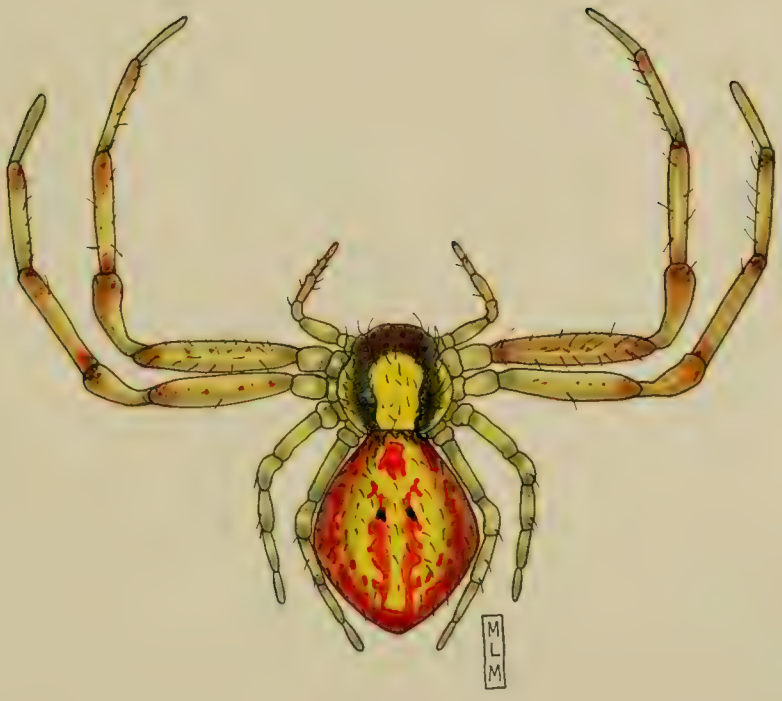

Plate III

Plate IV

Plate V

Three New Chalcid Flies From California

By A. A. Girault.

(Material for this paper was sent from the Zoological Department of Pomona College.)

Sympiesomorphelleus californicus, New Species.

Female: Similar to *nigriprothorax,* but twice larger and differing as follows: The stripe along the meson of the abdomen is narrower and is joined narrowly to base; the propodeum is all metallic green except narrowly along the median carina and broadly at mesal apex. The rectangular sclerite laterad of the postscutellum is metallic. There is a more distinct metallic spot near tegulæ. There is an oblique metallic stripe across the mesopleurum from the base of the caudal wing and an area of irregular shape on the mesopleurum over the cephalic coxa; also the cephalic third of the scutum is dark metallic, like the prothorax, and the scape is entirely black. Otherwise the same. The third joint of the club is nipplelike and may be articulated.

Described from two females from Claremont, California (C. F. Baker).

Types: Catalogue No. 20172, U. S. N. M., the above specimens on tags, a head and a caudal tibia on a slide.

The species *nigriprothorax* has the margins of the abdomen black; the parts mentioned in the original description of it are dark metallic.

Zagrammosoma mira new species.

Female: Very similar to *flavolineata* Crawford, but the abdomen bears no yellow spots, the entire caudal femur is metallic purple except at apex (only with a cinctus distad of middle in the other species), the extreme base of caudal tibia is more distinctly purple, the caudal coxa has more than a purple spot above at base, its basal third or more is purple, the yellow median stripe of the thorax is narrower and more uniform in width, the distal stripe of the fore wing is nearly or quite complete, though fainter coudad; there is no narrow longitudinal yellow stripe down parapside and axilla; and

also, the margin of abdomen ventro-laterad near base is not yellow; otherwise remarkably alike. In *flavolineata* there is a rather large area on lateral propodeum just cephalad of the caudal coxa (the propodeum laterad of the minute spiracles) and which has an oblique, narrow purple stripe at its meso-caudal corner; this is absent in this species. Both species bear a moderately long median carina on the propodeum, the latter *distinct*. In both species the vertex is purple nearly to each eye (between the lateral ocelli), and this is due to a broad purple stripe up the meson of the occiput which below the center (at the neck) divides and goes over to the eye where each arm divides again; but in *flavolineata* the small Y at the eye is broadly separated from the parent marking; one arm of this Y, the broader, meets the eye above the ventral apex on the occipital aspect, the other goes to the ventral apex of the eye, across the cheek. Description of *flavolineata* otherwise correct. On the vertex cephalad the purple apparently gives off a branch latero-cephalad, one (a very short one) going to the dorsal apex of the eye, the other down the face along the eye for some little distance; a very narrow median stripe on face between the antennæ and the mouth (the narrow median black stripe of *flavolineata*). Mandibles six-dentate. Scape lemon yellow at proximal half except above; club three yellowish.

From one female taken on the mountains near Claremont, California (C. F. Baker).

Type: Catalogue No. 20089, U. S. N. M., the specimen on a tag, the head, a caudal tibia and a pair of wings on a slide.

Pseudiglyphomyia unguttatipennis new species.

Female: Of the stature and general appearance of *flavicinctus*. Dark metallic green, the following parts bright lemon yellow: Legs (except a broad central cinctus on middle tibia and the hind coxæ), head (except ocellar area and upper three-fourths of the occiput), a round spot ventrad of middle of propleurum, a broad stripe across the dorsal and lateral and ventral thorax through the fore coxæ (including somewhat less than the distal half of the scutum, the parapside entirely and much of the cephalic meso-pleurum); cephalic half of lateral and mesal margins of axillæ; the distal fifth of abdo-

men, the yellow triangularly produced at meson and two cross-stripes on abdomen near base, the first narrowly interrupted at the meson. Fore wings hyaline but centrally with a large round moonlike spot, whose center is opposite the distal part of the marginal vein, the stigmal vein not extending distad of its most distal circumferential point; postmarginal vein distinctly shorter than the stigmal, the venation yellow. Antennæ dull brownish yellow, the scape and pedicel metallic green (except bulb and base of the former and apex and ventral side of the latter). Funicle 1 two-thirds longer than wide, subequal to the pedicel, 2 a little longer than wide. Club with a distinct terminal spine. Mandibles 5-dentate.

Pronotum large, conical. Propodeum with a distinct median carina, otherwise plane, the spiracles minute. Thorax scaly.

Described from one female received from Wm. A. Hilton and collected at Laguna Beach, Southern California (C. F. Baker).

Type: Catalogue No. 20173, U. S. N. M., the female on a tag, the head, a caudal leg and a fore wing on a slide.

Perilampus chrysopæ Crawford.

Three females, Claremont, California (C. F. Baker). Compared with types.

Perilampus canadensis Crawford.

This belongs in the first division of Crawford's (1914) table, and is closely allied with *subcarinatus;* but in the latter the lower face (laterad of the clypeus) is finely cross-wrinkled, but in *canadensis* it bears only a few punctures (and a line of smaller punctures up the eye margin); the lower cheeks are similarly sculptured for the respective species (that is, in *subcarinatus* finely striate, and so on). The carina referred to in the table is the carinated edges of the large scrobicular cavity (with the species bearing it, the face is striate, otherwise smooth or mostly so). The carina is weak in *robertsoni,* which resembles *similis,* but there is more sculpture on the head in the former; in *robertsoni* the venation is pale, black in *similis.* The species *subcarinatus* and *platygaster* are very much alike, but the latter has larger punctures on the clypeus and the lateral margin is cross-wrinkled, while in the first species the clypeus is practically smooth and with minute scattered punctures; more-

over, the venation in *platygaster*, is very pale and the parapsides caudo-mesad finely reticulated (glabrous in the other species). The carina on the face is a good character, but great care must be taken that it is seen; it may be rather close to the eye (*i. e.*, the long facial part of it). Types of *canadensis*, *subcarinatus*, *similis*, *robertsoni* and *bakeri* examined.

The species *bakeri* and *subcarinatus* are synonyms.

Some Remarks on the Central Nervous System of the Starfish

WILLIAM A. HILTON

There are several questions in connection with the central nervous system of star fish which, so far as I know, are not answered by older or more recent investigations. They are as follows:

1. Is there any special center in the radial or circum-oral nervous system?
2. If there are true nerve cells how are they related?
3. Are there true neurofibrillæ?
4. Is there any tigroid substance?
5. Is there any connection between the superficial and the deep radial systems?
6. Are all the elements in the central nervous system nerve cells?
7. Do different species differ from each other materially?

Six species of starfish were collected at Laguna Beach. Two methods were used for fixation; hot mercuric cloride or Flemming's fluid were used upon the whole animal. The first reagent was especially useful in extending the animals and whitening the radial and circum-oral nerves. Borax carmine was used with good results in staining after the first fixation and iron hematoxylin after the second. By both methods cells and fibers were clearly shown.

In all the specimens examined just after killing, the central portion of the radial or circum-oral nerves seemed like a definite line of nervous tissue. Sections showed in some cases a thicker epithelium in the mid-ventral line of the nerves. The radial nerve was often less thick than the central part of the nerve ring. The chief structural difference between the radial and circum-oral nerves in their central portions was in the arrangement of the cells and fibers. In these regions the nerve fibers seem to cross more and run in towards the middle line. This was *very* marked in some specimens. Some indication of this is given by Cuenot, 1890.

In the central nervous system there are unipolar and bipolar cells with long slender processes reaching through the whole thickness of

the nerve band. These fibers are for the most part unbranched except at the inner ends where most seem to be slightly forked just at the inner limit of the nerve band. There may be small branches to a limited degree along the sides of the nerve fibers, but it is very difficult to be sure that this is the case. Certain cells which may be multipolar did not seem true nerve cells. The terminal ends of the nerve cells on the inner side of the nerve band seems to be the chief, if not the only region of interrelation of the nerve cells. I did not find them quite so long or so numerous as Meyer, 1906. There are diagonal fibers, especially in the mid-ventral line of older and larger specimens. There are also a few fibers near the cell-body layer of the nerve strands, which are perpendicular to the other fibers. Very few bipolar cells were found except in the outer zone of nuclei, but there were a few.

The nerve fibers were not found to contain fibrillæ. Possibly each cell has but one fibril. Although the nerve processes differ in diameter none of them seem made of smaller elements. Often several processes from several cells run almost in a single bundle.

The cell-body just about the nucleus was often difficult to make out, although in some cases it retained its epithelial character at the outer end. No clear indications of tigroid substance could be determined.

The two deeper nerves in each arm are not so well marked as the superficial. They are much simpler in structure and not so clearly nervous structures although a few fibers are shown. At the margins of the nerve ring and the other surface nerve bands, there seems to be some connection between the superficial and deep systems, by direct junction in part and by individual fibers in small number passing from the outer to the inner nerve bands.

Most of the cells of the superficial central system seem to be nerve cells, the nuclei of the external zone seem to belong to unipolar or bipolar cells, but a few of these may not be. Between the fibers there is a granular mass which does not clearly show cells, yet there are some cells in it, some dimly shown larger ones and some marked smaller ones which have many fine branches. These smaller cells especially seem like neuroglia cells of other forms.

The following species of starfish were studied: *Linckia columbiæ* (Gray), *Orthasterias gonolena* (Verrill), *Pisaster capitatus* (Stimp.), *P. ochraceus* (Brandt), *Astropecten erinaceus* (Gray), *Asterina miniata* (Brandt). Except for size and difference due to body form, the nervous structures in these species were much alike.

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The nervous system of the Asterid*æ*. Linn. Soc. London, Vol. xxii.

(Contribution from the Zoological Laboratory of Pomona College)

EXPLANATION OF FIGURES

Fig. 1. Cross section of the circum oral nerve of *Asterina miniata.* X55.

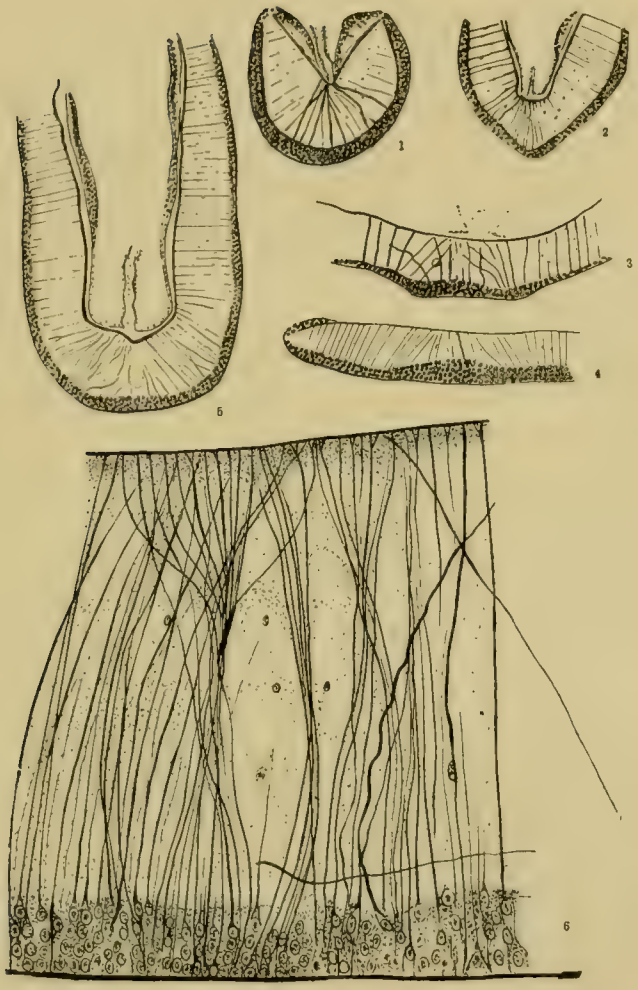
Fig. 2. Cross section of the radial nerve of *Linckia columbiæ.* X55.

Fig. 3. Cross section of the radial nerve of *Pisaster ochraceus.* X55.

Fig. 4. Cross section of the radial nerve of *Astropecten erinaceus.* X55.

Fig. 5. Cross section of a very large specimen of *P. ochraceus.* X55.

Fig. 6. A portion of the middle line of a cross section of the radial nerve of a large specimen of *P. ochraceus.* X800.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The Growth and Color Patterns in Spiders

MARGARET L. MOLES

The growth of immature spiders, from the period of emerging from the egg case to that of the adult were studied. Representatives of seven large families, the Lycosidæ, Attidæ, Avicullariidæ, Epeiridæ, Thomisidæ, Theridiidæ and Oxyopidæ, and the life cycle of one genus and species of each of the families were minutely described and drawn in colors. Besides noting the changes in body developments, coloration and color pattern, the methods of emerging from the egg case, action of spiderlings upon "hatching," the growth of all their parts and especially the growth of the color patterns, was noted. On account of the artificial conditions in which it was found necessary to raise the young, they did not always live to reach maturity, but were almost always raised at least up to the last few moults.

The females were collected with the eggs. The young were placed in glass dishes with cloth tops; leaves and dirt were placed in the jars in order to resemble their natural environments. Food was given once a day. It consisted of large flies whose bodies had been opened. Water in small drops was given each day. Some of the spiderlings such as Lycosidæ and Oxyopidæ were especially fond of the water and congregated around each drop in great numbers. The food given the young seemed to satisfy them. They would crawl all over the fly as soon as it fell among them and soon it could not be seen in the mass of spiders. Small gnats were put in the cages but no attempts were made by the small spiders to catch them. They were able to go for days at a time without food if given plenty of water.

The greater number of female spiders with their egg cases were collected during the months of October, November and December. The cases of the Oxyopidæ were found in the mountain canyons under piles of damp leaves, those of the Epeiridæ were found in the usual garden places under eaves and fastened under the leaves

of large vines. Theridiidæ were found in meter boxes and barns; the Attidæ were collected in Imperial Valley under rocks; the Lycosidæ which were collected during the month of April, were found in the grass with the females carrying the egg cases. The young of Thomisidæ were found, no eggs having been collected.

The shape of the egg cases of the several species studied differed materially. Those of *Peucetia viridans* are, as Comstock describes it, "hemispherical in outline with small projecting tufts." The egg sac of *Aranea gemma* is a light brown "loose flocculent mass of silk enclosing the ball of eggs." The egg case of most of the Thomisidæ, Comstock describes as being "lenticular in form" and are usually formed of two equal valves united at the border, which presents a little circular fringe. The egg case of *Philodromus* is made up of two disks which are fastened closely to the bark of the trees and may be more than lenticular in shape. In the subfamily *Misumeninæ* the egg sac is sometimes free and sometimes suspended like a hammock in a retreat formed of leaves rolled or drawn together. In most cases after the egg sac is made, the female stops her wandering habits in order to watch it. The egg sac of *Latrodectus mactans* is made up of a round closely woven silk ball, hard on the exterior and soft on the interior. Dust soon collects on the egg sac which gives it a dirty white color. They are suspended from the web by a few loose threads. The Lycosidæ tie their children to their apron strings. The females were found in great abundance in the early spring holding the flat circular egg case firmly with their mandibles. These cases were held up off the ground when the female moved and were dropped if she was disturbed. In the confined specimens the female upon being disturbed would drop her bundle, but as soon as the disturbance was over she would pick up the case again. The Attidæ were all collected from a valley with a warm climate and seemed to resent the change when they were placed in the cooler atmosphere of the laboratory. Their egg cases were of a very fine soft white silk and were attached to the under side of a rock, using the rock as one side and building the nest around that side. One female laid her eggs in captivity. The case was the same as those on the rocks but one side of the glass was used as a foundation. As there were

no eggs of the trap door spider collected, I cannot consider the shape of the egg case and none of the authors of spider life histories describe it. Comstock speaks of finding one in Florida, but does not describe it.

The general shape of the egg cases of the different species studied, seemed to be the same in all of the egg cases of that species. Comstock says in regard to the constancy of the shape of the egg sac of the species, "The egg sac is not merely a covering made in a haphazard way; but is a more or less elaborate structure, made in a definite manner characteristic of the species." While one cannot determine the species or genus of a spider definitely by the shape of its egg sac, yet it is a small factor which might aid in telling the genus.

The young of the different species differed widely in the length of time of emerging. *Peucetia viridans* emerged in a month, *Arenea gemma* in from two to three weeks, *Lycosa* sp. in three weeks, *Phippdus* sp. was kept for seven months and then artificial help was given to open the sack. The eggs of most of these species hatched soon after being laid.

The spiders made one or more moults in the egg sac before emerging from the case. In the case of *Aranea* it was seen that a great pile of shed skins were exuded outside of the sac just before the young emerged and then while emerging from the sac they went through another moult, leaving their shed skins in the case or just outside on a line which they made. From observations it would seem as though this species moulted two or three times before emerging from the sac. "The young attids, having undergone the moult, shift their positions to the opposite end of the cocoon and then moult a second and even third time before egress; as is shown by the fact that one finds within the same cocoon three separate heaps of skins cast at different ages." The young with the aid of a great deal of heat emerged two weeks after the eggs were laid. They had not moulted at all and were very weak, and came from one end of the cocoon. The case that was left for seven months showed that the young had deposited their shed skins in three places before emerging, and having migrated from one end of the egg sac to the other. Wagner ('88) asserts in "La Mue"—

"The young of Lycosa remain in the cocoon until the second moult, after which they emerge and clamber upon the mother's back where the third and fourth moults occur before the little fellows begin independent housekeeping in miniature burrows of their own." With the other species it was difficult to see how many moults occurred before egress from the sac and no accurate data was found upon it.

There was a great difference between the different families in the actual time of emerging. The Attidæ, Lycosidæ, Theridiidæ and Oxyopidæ seemed to pop right out of the sac like ripe peas out of a pod, while the Araneinæ took from one to two days or a few hours, all according to the heat and sunshine. Those egg sacs which were kept in a dark box were very slow in emerging. One little one would force its way out of a corner of the cocoon, spin a line of web to the corner of the box and spend all the rest of the day running up and down that thread. The others might not appear for a day or two. If the box with its one little occupant was placed in the sunshine, inside of two hours every one of the spiderlings would be out spinning. Egg sacs which showed no signs of hatching were placed in the sunlight and within two hours one little one would be out and the rest soon followed. These experiments with the dark and light in reference to the length of time of emerging were only carried on successfully with those of the Araneinæ. The other egg sacs were placed in sunshine each day but it did not seem to force the young from the sac. The Attidæ came out with the application of both heat and sunshine, but seemed to be prematurely "hatched," as they were inactive and soon died. Sunshine alone did not force them out, but the application of heat was sufficient, after a day's application. The natural time of emerging for the Attidæ is in hot summer weather so this in a way explains why heat was so effective. Heat or sunshine had no effect upon *Latrodectus* or *Lycosa* except just at the time of emerging. They could not be forced to emerge. A definite conclusion was reached,—that the young will wait for a sunny day to emerge. This seems to be true of all families. Not one was found which had emerged upon a cold, cloudy day. The house-raised spiders of all the groups studied emerged earlier than the ones out-of-doors in their natural

habitat. The difference in time with all of them was from one to two months. This could be accounted for by the fact that they were raised in a steam-heated room and were placed in the sunshine from two to three hours a day even in winter, and so developed quicker. Artificial help was given to some species which seemed to have trouble in emerging. The mother spider in some cases cuts the silk of the cocoon and so when some species were particularly long in hatching, a pin point was inserted and an opening made. Without the help of the female *Lycosa* the young were not able to emerge at all. The young would develop in the egg sac up to the emerging and then would dry up, if not given artificial aid.

The actions of the newly-emerged young of the different species were constant. *Lycosa* upon emerging clambered upon the body of the mother, nearly covering the mother spider. The lycosids which were hatched artificially and had no mother to clamber on died soon after emerging. The young which emerged and were carried by the mother all lived, but the others did not seem to have the necessary strength. The mother often seemed anxious to get rid of the young. If disturbed she threw them off, and if they were too young they died. A female without an egg sac was put with an artificially opened sac and soon the young clambered up on the legs and abdomen of the adult without any response from her. Another female carried her own egg sac and a load of orphans which were placed with her. This double load seemed to be too much for her; for she died before her own brood could emerge. The brood which had lived on her a week while she carried her own case, lived. After she died they started an independent life, but generally the young live on the mother two weeks after emerging. These experiments would seem to show that to some degree the life of the young depended upon the existence of the mother. None of the other families studied had this dependence of the young upon the mother.

The young of *Peucetia* built simply a line of thread and stayed on it or ran around the jar unattached by any silk. The *Thomisidæ* when very small would climb upon the flowers or leaves and bark, seemingly waiting for little mites or flies. *Latrodectus* and

Lycosa built neither web nor thread rope, but ran round and round the jar. No attempt was made to build separate homes or protections. *Phippdus* after one day of outside life built small retreats such as the mature build under the rocks. Of course, the nests were very small and thin, but they were exact duplicates of the large ones. Three or four little ones lived in the same retreat but more often each had his own. Comstock claims they use these nests as places to stay in while they moult. The nests were built along the upper edge of the jars and from the nest to the bottom of the jar was a line of silk thread used as an elevator. The trap door spiders stayed in the bottom of the tunnel except when placed in the sunshine; then they spread all over the sides of the tunnel and especially around the edge of the trap door. As a general thing the young were very slow and sluggish in actions. The young of the trap door spider must be very slow to develop for they showed no signs of silk spinning nor any desire to go out of the parental tunnel. Some of the young were removed when four months old and placed in a jar of dirt in order to see if they would form small burrows of their own. All of them refused to make any burrows and dried up on top of the dirt. The young of about one year of age were found in small burrows. Miss Thompson in her observations on the trap door spiders, says, "After the hatching of the eggs from seventy-five to one hundred black and green spiderlings will be found occupying the maternal nest. When these are a few weeks old they leave the native burrow and begin to excavate in sunny places, minute tubes of their own. Often a dozen such small abodes will be clustered about the old trap door. These vary greatly in size but all are quite perfect in form."

The actions of the young *Aranea gemma* were the most interesting of all the young. The instinct to use the spinnerets and to make webs was strongly developed, for as soon as the young emerged from the egg sac they began to spin. First a small thread was put out and attached to the sides of the jar and as soon as the young had found a suitable place an orb web was begun. These were very perfect, although not as large nor having as many complications as the web of the mature spider. Some of the young

were taken out of the jar and soon scattered all over the laboratory. They built their miniature orbs between the legs of chairs, on the lighting fixtures, on the microscopes and in every available place. They would place themselves in the center of these small orbs and stay there all day. This action of the young is quite contrary to that of the adult, who does not remain in the orb but in a hiding place near by. The young of *Aranea gemma* were found all over the top of a rose fence in little webs. They made them in the top in order to get the greatest amount of light and sunshine. A family of *Aranea* was raised in the laboratory windows on the vines. Their actions were not the same as the one raised indoors. They remained in a large clump swung from one of the branches of the vine and only on bright days did they scatter from this mass to return when the wind blew and it became cold. A hard rain storm came and all the spiders disappeared, but when the sun came out the spiders returned, making little orbs of their own, but did not go back into a mass. A great many of these little ones could not have survived the storm, but some must have remained under the leaves and started life anew as soon as it became warm.

Certain conclusions can be drawn in connection with the shape of the egg case, the methods of emerging, and the actions upon emerging, of the immature spiders:

1. All the egg cases of a certain species of spiders were found to be exactly the same. There were large numbers of the egg cases of *Aranea* collected, and none varied in either shape, texture, or method of building. The only variations found were in size and color. The colors varied from light to dark brown.

2. The methods of emerging, the length of time and actions upon emerging varied only according to the weather conditions and situations, so the same statement may apply to them as to the shape of the egg case.

In a general collection a great many specimens taken are immature and very hard to determine on account of the undeveloped sexual organs, and the differences in color pattern between the immature and its adult. It has been the aim of the writer to watch the changes in the color development and color pattern of certain well-known species of large families in order to find some way in

which the young may be identified by the color pattern and color. There have been few sources from which any material upon this subject could be found. Comstock in his "Spider Book" makes no note of the color changes, but McCook makes the following observations: "With each moult spiders undergo a change in color and patterns more or less decided; but some undergo such decided changes that different species have been established for the same spider upon specimens taken after different moulting periods. In some species the color and markings of the younglings, after the first moult or two, fairly represent the markings of the adult at maturity; in others the difference is so great between the two stages of life that it is quite impossible to identify young individuals or distinguish the young of several species with accuracy."

The female colors predominate through all the young, the immature males in the most cases taking the colors and markings of the female until the last moult, when they then take on the markings and characteristics of the adult male.

In the following pages of the paper there will be found a description of the different stages of the spiderling of different species, especially in reference to the different color stages... The dorsal side of the spider has the color pattern, therefore it will be the surface which is always described.

Peucetia viridans Hentz. Plates I, II and III

The color markings of the adult female were very brilliant and beautiful. The eye space is black, the cephalic part of the cephalothorax is light yellow with red and brown markings, the thoracic region is a dark green ground color with two red lines running down and around the sides of it. There is a median brown line extending from the eye space to the lower edge of the cephalothorax. The abdomen has a dark brown ground color with four white spots, the lower two of which are edged with red. On the upper half of the abdomen are two orange stripes flecked with red and separated by a light green stripe with a darker one in its center. The lower half of the abdomen has two light green and two yellow green stripes on either side of the median line. There are numerous flecks of red all over the dark green on the abdomen. The spin-

nerets are dark green, covered with black hairs. The abdomen has black hairs. The legs have a light yellow ground color. The coxa has two red lines near the upper margin of the joint and two black spots below the lowest line. The trochanter is covered with various sized black spots. There are two irregular red bands on the upper margin, while there are scattered over the surface of the joint from three to four irregular red dashes. The femur is orange yellow with an irregular red band both at the upper and lower margin of the joint, the surface of the joint having only two black spots and those placed at the base of the spines. The tibia is yellow gray with dark gray spots and an irregular red band both at the upper and lower margins of the joint. The metatarsus is also yellow gray with dark gray spots and an irregular orange and red band on the lower margin of the joint. The tarsus is dark yellow gray. The joints of the legs with the exception of the coxa, trochanter and femur are covered with fine black hairs. The palpi have the same coloring as the legs, but lack the black spots, which are on all the trochanters. The spines on the legs are very black and long.

The newly emerged *Peucetia viridans* are pale orange. Plate II B. Some of the young emerged and shed a coat after three days, while others emerged with the new coat on. Those which emerged and shed their coats in three days were orange yellow when they first appeared. After three days they acquired a more orange color. The eye space was dark brown, the cephalothorax a light yellow green ground color, the sides red shading into green and a dark brown spot on the upper half of the median surface and a dark brown median line which extended from the eye space to the ending of this dark brown median area. This dark line is the same as in the adult and is lost in the next moult and does not appear until the adult stage again. The abdomen is orange, shading to orange red on the sides and to light yellow on the upper surface. There is a beginning of a light red folium of complicated inner pattern, looking like the construction of a Chinese pagoda. On each section of the pattern there were four little light colored pits, but the upper one had five. The palpi were dark gray, the coxæ of the legs were dark gray, the rest of the joints of the legs were

a light apple green shading down to yellow green in the metatarsus and tarsus. Near the upper margin of the tibia were four small red rings. One can very well see that even in this early stage there is a good beginning for the brilliant markings of the adult. The next moult took place in ten days. The coloring of the cephalothorax and abdomen remained the same except where there had been small white pits on the abdomen in the earlier stages there now was a black spine for every pit. It was in the legs where the greatest change took place. The ground color of the legs was light lemon yellow. The coxa was light lemon yellow with three black spots; the trochanter had eight to ten black spots, the upper margin of this joint being yellow green; the femur had from four to seven black spots, with patches of apple green. The tibia, metatarsus and tarsus were orange with darker orange at the upper and lower margin of the joints. The tibia and metatarsus have from two to five black spots, the tarsus of the first two legs has two black spots, the same joint of the last two legs has none. The light yellow palpi have two black spots on the trochanter, femur and tibia; the other joints are bare. The spines appeared on the legs in this stage, while not all that are found on the legs of the adult were found, yet a good portion were started of very good size. No short hairs had appeared yet on the body or legs.

There were two moults between this stage and the next one minutely described, but in either moult there was not any marked external change other than in size. The body changed from a round, short, thick shape to a long oval abdomen with a large cephalothorax to a shape almost like that of the adult. (Fig. C, Plate II.) The next stage in the color pattern development occurred when the young was twenty-two days old. (Fig. D, Plate II.) The eye space is beginning to narrow at the lower margin, the median part of the thoracic portion of the cephalothorax is dark brown with light brown center. This dark stripe has two horns toward the eye space and two small hair lines at the lower margin of the cephalothorax which extends to the edges of the cephalothorax. On the edge of the cephalothorax is a small red line and next to it a dark brown irregular line broken by green spots. The space between the median dark line and the dark irregular brown

line on the edge is apple green. The abdomen has the same pattern as in the younger ones, only outlined by a darker red. Around the first two portions of the pattern is a white space. This white space is found in the adult, only separated into two areas. The upper portion of the abdomen has a ground color of orange yellow with darker orange edge, while the lower portion has a great deal more yellow in it. The legs have the same coloring as in the last stage described, only areas of gray coloring have appeared in the lower margins of the femur and the upper and lower margins of the tibia and the end of the tarsus. On the palpi we find the gray on the upper and lower margins of all the joints except the coxa. The spinnerets protrude below the abdomen and are covered with short black hairs. (Fig. D, Plate II.)

The next stage seems almost a retrogression in the color development except for the growth of the cephalothorax. (Fig. E, Plate II.) The eye space has assumed a small position in the center of the cephalic portion of the cephalothorax. The color is brown. On either edge of the upper margin of this portion of the cephalothorax are found two brown spots which are on the adult. The median stripe down the center of the cephalothorax is green with dark brown splotches and the same shape as the others. The edges had a light brown irregular stripe and all traces of the red band was gone. At the joining of the green median stripe and the brown stripe near the lower margin of the cephalothorax was a black spot showing the beginning of the black spot in the same place in the adult. The space around the eye space and on either side of the median stripe was light yellow green. The abdomen had lost nearly all the folium except remains of its outer edges. The upper portion of the abdomen is light yellow, nearly white; the lower portion yellow green; the remains of the pattern in the center of the abdomen. The white space on either side of the folium remained and the lower portion of the sides of the abdomen was a pinkish yellow. The abdomen has become slightly constricted near the upper margin and has assumed a great deal of the shape of the abdomen of the adult. The legs are a transparent color. The coxa has besides the gray at the upper and lower margins, a band of green on the upper margin. The trochanter was light gray, almost white, with

a red band near the upper margin of the joint, the femur of the first two legs was yellow green with gray at the upper margin, and a large black splotch at the lower margin on the side; the femur of the last two legs is the same color but lacks the black spots; the tibia, metatarsus and tarsus are yellow gray with darker gray green at the upper and lower margins of each joint. From now on until the last moult there was no change. At the last moult the sex of the spiders appeared and the color pattern was completely formed. Though the young with the complete color pattern were not as bright and brilliant as the mother caught with the eggs, yet they would very likely improve with age. The color pattern of this form was the hardest to follow and understand. At each moult it seemed to be a process such as is necessary in the reproduction of a colored plate, one color placed on top of the other until the final whole is obtained.

A female *Peucetia viridans* with eggs was collected in the early summer (July 1st) on a squash vine. (Plate III.) The female was colored differently from the one just described above, and also different from the one described by Comstock, yet this one is identified by Banks as belonging to this genus and species. The cephalothorax of the adult was a light yellow green with a silver eye space. There were two black lines on the lower margin of the cephalothorax. The abdomen is a dark brown green ground color, with a band of light green on either side of the median line near the upper margin. Near the middle of the abdomen are two white spots. A light brown triangular pattern is found in the median line near the upper margin. The legs and palpi have a light green coxa and trochanter, an orange femur and a yellow tibia, the metatarsus and tarsus with a green band both at the upper and lower margin of each joint. The trochanter is flecked with black spots. The legs are covered with strong spines. The spinnerets are dark brown.

The young emerged after two weeks and were dark brown, the abdomen being darker than the legs and cephalothorax. At this time there was no semblance in the young to the adult in either shape of body or color. The first moult occurred in one week. The shape of the body had changed to the elongate abdomen and

large flat cephalothorax of the adult. The cephalothorax was yellow brown with a line of green on the sides of the thoracic portion of the cephalothorax. The pattern along the median line of the cephalothorax is the same as that found in the young of the same age in the other specimen of *Peucetia viridans* described. The cephalic portion of the cephalothorax is yellow brown, the eye space is brown. The abdomen is brownish green with a slight beginning of a folium in red. The legs were yellow green with darker green spots at the upper margin of each joint. The trochanter, femur, tibia and tarsus have a varying number of black spots. After one week there was another moult. The legs and palpi had not changed except in size. The cephalothorax had a little more green, the upper part very bright red at the center and shading down to the gray green of the abdomen. The folium was outlined in red, the upper part very bright red at the center and shading down to a very light red and green in the lower part of the abdomen. The spinnerets were dark, covered with black hairs. In a week another moult took place. The cephalothorax was light green with a band of dark on either side. The eye space was dark brown. The pattern along the median line was in dark green. The abdomen was dark green, the irregular pattern along the median part of the abdomen was in light green brown. The legs were light green, the femur light yellow, the spots being at the base of the spines on all the joints except the trochanter. After the next moult which took place in two weeks, the young were like the adult in everything but size and sex differentiation. Whether this form could be called a variety or not could not be said, but certainly in development of the young and in the adult itself there is a great difference between it and the desscribed *Peucetia viridans.* The time when each was collected, and the difference in location may have influenced the color and color development, but it esems highly improbable that it could have affected the young as well.

Aranea gemma McCook. Plate IV

The next group studied was the *Aranea gemma.* The color pattern of the adult was: The cephalothorax was dark brown, almost black and covered with light yellow hairs. The abdomen was a

lighter brown with a broken yellow median line. This line extends from the upper margin, three-fourths of the way down on the cephalothorax. The dark brown abdomen is also covered with yellow hairs. These yellow hairs gave a grayish appearance to the body. The coxæ of the legs and the palpi were dark brown, the trochanter light brown, the femur dark brown; the tibia, metatarsus and tarsus a light yellow with upper margin of each with a dark brown band. The legs were covered with light yellow hairs. The brown spinnerets were covered with dark hairs.

The young when first emerged were a dirty gray brown in the legs, palpi and cephalothorax; the abdomen was a clear yellow brown with a distinct black triangular pattern near the apex. The tarsus of the legs and palpi were dark brown. Some of the spiderlings kept this same coloring and pattern for a month, simply growing in size. Others in the same brood kept this same color and pattern for two weeks and then changed. At this time the legs became a clear light brown, the tarsus being also of the same color; the cephalothorax was the same dirty brown. There were two cervical grooves, one separating the head from the thorax and then at the joining of this groove another one started toward either side at the base of the cephalothorax. The abdomen was the same clear yellow brown, only at the base of the abdomen near the upper margin and on either side, small patches of brown indicated the starting humps of the adult. The black triangular pattern of the one just described was softened to a dark brown pattern fusing into the color of the rest of the abdomen. It was not until the spider was four months old that there was any great change from this one, only of course, the general growth of body. The color remained the same except that at each moult it was darker. At the end of four months the humps had developed into small knobs. The abdomen and cephalothorax had become like the adult female, but the legs had not taken on the gray coloring of the adult. They were still a dirty brown. As both adult male and female are alike in coloring, both sexes of the young remained the same in coloring throughout their life, the female being larger in the last few moults.

As none of the egg cases of *Thomisidæ* were kept in captivity all the observation on the young of this family were made from young collected.

A great number of juveniles of the species *Misumessus asperatus* were collected and only the approximate ages can be stated in the following discussion of them. The adult female is described as "pale yellow in color with dull red markings or the ground color may be greenish. There is a brownish stripe on each side of the thorax, a median light red band on the basal half of the abdomen, two bands or rows of spots on the hind half and a band on each side. The male resembles the female in colors and markings, but is only about one-half as long." The newly-emerged are light yellow in color of abdomen, cephalothorax and legs, with slight reddish markings on the sides of the cephalothorax and the dorsal portion of the abdomen. At the age of three months the males could be separated from the females although the palpi showed no differentiation, but the size of the two were quite distinct. The male at this age has the bright yellow cephalothorax with a brown band on either side of the median space. This band does not go to the side of the cephalothorax but extends around the anterior and posterior lateral eyes. The abdomen is marked the same as the adult, only not so distinctly. The coxa, trochanter and femur of the legs and palpi are light yellow brown with an indistinct reddish band at the upper margin of each joint. The tibia, tarsus and metatarsus are light yellow. In the adult male, the coxa is yellow brown, the trochanter and femur are the same with a small red band at the upper margin of each joint and the upper half of the tibia, the metatarsus and tarsus are dark red. The trochanter is covered with small dark red spots. The spines of the juvenile male had developed at the age of three months to the size of the adult spines. In the matter of size, the juvenile was about three-fourths the size of the adult. The juvenile female of the same age was marked like the adult, only fainter, and the size was about the same proportion as in the other sex.

In following through a life history of *Philodromus pernix*, *Xysticus Californicus* and *Misumena aleatoria* it is found that the color changes that take place from the newly-emerged to the adult indicate the pattern of the adult. The colors may not be as distinct as on the adult, yet on each succeeding moult the pattern becomes plainer. Thus it can be said that the *Thomisidæ* change very little from the immature to the mature in the case of color and pattern.

Latrodectus mactans Fabricus. Plate V

Of the family Theridiiæ, *Latrodectus mactans* was studied. The color of the adult female is coal black, often having a broken row of red spots down the median line of the abdomen; the female is black with four red stripes on the abdomen besides the broken red line down the median line of the abdomen. The female is often lacking the red color and then is pure black. The young are a light yellow gray white upon emerging, but in thirteen days after their first moult outside of the egg case the cephalothorax was bright yellow brown with darker brown sides and a triangular brown spot in the median area of the cephalothorax reaches to the eye space. The abdomen was white with four varying sized black spots on its surface. The coxa and trochanter of the legs were yellow brown with dark gray on the upper margin of each; the femur, tibia, metatarsus and tarsus were light brown gray with dark gray on both upper and lower margins of each joint. The palpi were marked the same as the legs, but with a great amount of dark gray color. The next moult occurred when the spiderlings were twenty days old. The thoracic portion of the cephalothorax was dark brown, the sides had a dark gray band and the lower margin of this part of the cephalothorax had two dark gray spots. The pattern on the median portion of the cephalothorax was more slender and very black brown. The eye space was light brown. The abdomen was a dirty gray ground color. The black spots on the one described before had enlarged and between these rows of spots were two more broken lines of black spots. The pure white color remained only near the margins of the abdomen and as a median stripe. The legs were dark brown with darker black brown on the upper margin of each joint except the coxa. The palpi were light brown having lost all their gray color. At thirty-four days of age the cephalothorax had grown lighter, the margins were black with a brown stripe bordering the very thin black one. The triangular brown pattern on the median area had spread from the eye space to the lower margin of the cephalothorax. The abdomen had the dirty gray ground color except for the pure white median stripe. The abdomen had now three horizontal small black broken lines and four large black spots and two broken black lines bordering

the median white stripe. The lower margin of the abdomen was very dark gray. The legs were light brown with dark brown at the upper margins of all except the coxa. The palpi were light brown except the last joint which was dark brown. At forty-one days of age the cephalothorax was a dark brown gray ground color with a black broad stripe around each margin, the legs were dark gray brown with darker gray at each upper margin. The abdomen was black except for a median white stripe which went from the upper margin three-fourths of the way down and a stripe that extended down around the margins the same distance. From this time on until the last moult, the body became suffused with black, the space left on the abdomen which had been white was filled with red, and the males were distinct from the females. Some of the white spaces never filled with red but became black. Comstock states in his Spider Book, 1910, that it is known that the immature females are often marked like the mature males, but this was not found to be so in the artificially raised families which were grown in the laboratory. The red marking and color did not come until late in the last moults.

Lycosa sp. Plate VI

The next large group studied were the Lycosidæ. The genus and species studied were *Lycosa* sp. The adult female and male were alike in color and pattern. The cephalothorax was dark brown with a wide median light brown stripe extending from the anterior eyes to the lower margin. The space between the eyes was shiny black. At the base of the sides of the cephalothorax were two light brown spots. The abdomen was black brown with uneven spots of light brown on the basal half and in the dorsal half were two horizontal light brown stripes. The legs were gray brown with dark bands on all the joints except the tarsus and metatarsus. The young, when emerged, have a dirty gray cephalothorax with a wide light brown median stripe extending from the second row of eyes to the base of the cephalothorax. The color around all the eyes is black. The abdomen is a dirty gray with a few dark spots on the median line. The abdomen and cephalothorax are covered with long black hairs and a few white ones. The legs are light yellow

brown with black hairs. At the age of two weeks the cephalothorax was a dirty brown, the sides had a small black line along the edge, there was the same wide median light brown band extending from the second row of eyes down to the lower margin and on either side of this band was a large gray band. The space around the eyes was black. The abdomen was a dark gray ground color with a light brown median band broken by lines and spots of gray. The hairs were long and black, some of the hairs on the abdomen being three-fourths as long as the spider. The legs and palpi were light brown with faint gray band on all joints except the coxa, tibia, tarsus and metatarsus. At three weeks of age the abdomen was the only thing changed. It had changed to that of the adult in color and pattern. The legs, palpi and cephalothorax were the same as at two weeks of age. At the age of one month the *Lycosa* young were miniatures of the adult. They were about one-tenth the size of the adult at this age.

Phidippus sp. Plate VII

The Attidae studied were large undertermined desert forms of the genus *Phidippus* and taken in the winter from under rocks. The adults had black cephalothorax with a red spot between the posterior eyes. The abdomen was a reddish brown ground color with a gray stripe around the upper margin, and a gray folium at the lower half of the abdomen. The young were very hard to raise and lived only a week in some cases. One set emerged in the winter and lived only a few days, but from another egg case, young came forth with artificial aid, after being kept seven months. The cephalothorax of the newly emerged was dark green, the abdomen dark green with two lighter green spots and lines surrounded by black on the forward portion of the abdomen and four dark horizontal lines at the lower part of the abdomen. The coxa and trochanter of the legs were gray green, the rest of the joints were orange yellow.

Bothriocyrtum Californicum. Plate VIII

Of the family Avicularíidae the trapdoor spider was observed. The adult has a chocolate brown cephalothorax with a deeper chocolate brown on the abdomen, the legs being the same color. The

newly emerged young were shell pink and shiny. After emerging from the egg sac they moulted and at three days of age had a light brown cephalothorax with black eye space, light brown legs and spinnerets and a reddish brown abdomen. The legs, abdomen and spinnerets were covered sparsely with dark hairs. The trapdoor spiderlings were so slow in changing that the moults occurred about a month apart. At the age of one month and three days the young had grown slightly larger, the cephalothorax was light brown with darker brown in the cervical groove. There was a brown line from the black eye space down to the first groove ending. The legs and spinnerets were the same color as before. The abdomen was colored a little darker brown and six light spots were on the middle surface of the abdomen. The spinnerets were shorter than at the three-day stage. At the next moult (two months and six days), the shape and coloring of the spiderlings had changed considerably. The cephalothorax had elongated, the color was red brown, the eye space black. The abdomen had become smaller and the spinnerets disappeared from sight. The color of the abdomen was dark reddish brown with numerous flecks of lighter brown over the surface of the abdomen. The legs and palpi were gray brown. At three months and six days the whole spider had changed from the reddish brown color to the chocolate brown. The cephalothorax was chocolate brown with black eye space. The abdomen had become the shape of the adult's and was a dark chocolate brown with numerous horizontal ridges. The legs were gray brown. At the age of four months the young had taken all the color of the adult, though their size was only one-tenth that of the mature spider. There is in the collection a specimen of *Bothriocyrtum* of about a year's age. It is three-fourths the size of the adult, and though its sex is not differentiated yet, it has all the adult coloring. From these observations it is concluded that it must take several years for the spider to reach maturity.

The conclusions reached after the study of these families of spiders may be stated in a few paragraphs:

1. The young in all cases resemble the adult in shape of body, placing of eyes and in habit. This was true of the young just emerged from the egg sac as well as the older ones. The shape of

the body might not be exactly as the adult at the beginning, but even then it was in most cases enough like it to help to determine the family. By shape alone could one tell a young attid or young trap-door spider. The position of the eyes was the same as the adult in all cases.

2. Color changes took place without the aid of moulting. It was noted with all the specimens that slight changes took place, such as darkening of the ground color, or a clearing of the pattern between moults. This was not true of body changes, as they only occurred through moulting, but it is true that then, and only then, occurred the great and varied changes of coloration and color pattern. This view of the color changing between moults is not held by most of the writers upon spiders, and it is only through daily observation that this slight changing can be seen.

3. The lack or abundance of food was found to be a great factor in the rapidity of moults and also the color development. The poorly fed spiderling moulted slowly and showed very little difference of color with each moult. The satisfied spiderling moulted at definite periods and showed great development of color as well as development of body. The intensity of the colors always became greater after a meal. Heat and sunshine also were factors with the food. The spiders kept in a dark place had as much color in their bodies as those in the sunshine, but their development was retarded.

4. There was a great difference in the amount of change in the color pattern in different species. Some had a good many, some only one or two. The ones with the greatest number of changes were the brilliantly colored adults or the striking adults. The Thomisidae, Lycosidae and Avicularíidae had very little change, and the young of any of these could be told at once by their close resemblance to the adult. The changes from the immature to the adult in these families were finished after the second or third moult from the egg case. The sexual differences did not appear until later.

5. The young in one brood looked all alike and resembled the adult female. This was true up to the last few moults. McCook in his book states: "Among the young of the *Lycosa* and *Attus*, according to Wagner, these modifications are effected with the

female and male so equally and uniformly during the first four or five moults and with *Trochosa* during the first six or seven moults, that one is scarcely able to distinguish the sex. Among orb weavers generally, and in spiders of various tribes observed, the change in color is not decided in the male; that is, the young male carries the typical color and general shape of the adult female, the younglings of both sexes after the initial moults resemble each other perfectly, and tend to resemble the adult female. Though the young male of *Dictyna* p. bears a close resemblance in color and pattern to the adult female. He concludes that when the adult male is more conspicuous than the adult female, the young of both sexes take after the latter in form and color. On the contrary when the female is more conspicuous the young follow the more modest colors of the male, especially in the earlier moults. When the adult sexes resemble each other the young of both favor the common type."

6. The Adult Thomisidae change color and color pattern according to their environment, but this is not so true of the immature.

7. (a) An adult spider whose ground color is brown, has young whose first ground color is yellow and then later becomes suffused with brown.

(b) The young of an adult whose ground color is green, is first yellow and then green.

(c) A gray spider has gray young.

(d) The black of all spiders, except *Latrodectus mactans,* is brown black, not pure black.

(e) The only color found in spiders, due to refracted light, was in the mandibles of Attidæ.

If the color sequences of all spiders were known, it would be an easy task to determine any immature form, but even without this knowledge it is not impossible to determine to what large family or group an immature specimen belongs. Three things have to be considered in the determination: First, that the young resemble the adult in form; second, that the eye placement of the immature is the same as that of its adult; third, the ground color of the immature is the same as in the adult. In this last it may lack in intensity or differ in shade. This may not be true of the first color, but remains true for the second moult.

If we study the color of the adult, and see how it is made up and how placed, and then apply this knowledge to the study of the immature, it will be found that the latter will usually show something of the adult color and color pattern.

(Contribution from the Zoological Laboratory of Pomona College.)

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A large number of works, both of early and recent writing, have been looked over, but as they had little or nothing upon the subject of the paper, they were not listed.

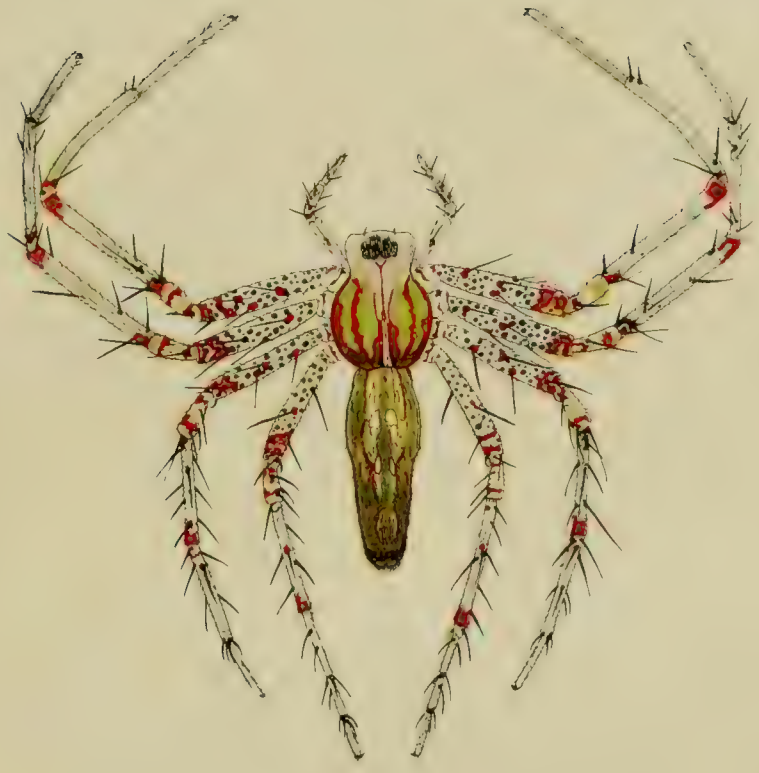
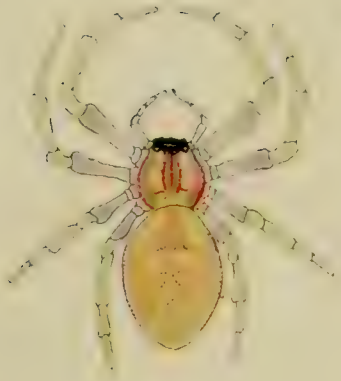


Plate I.



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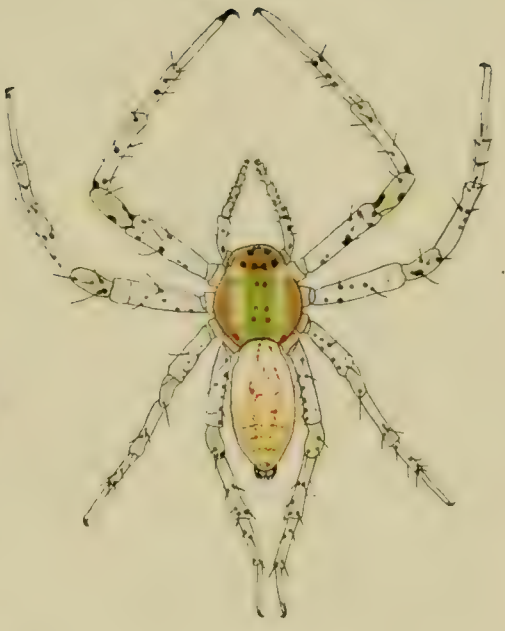

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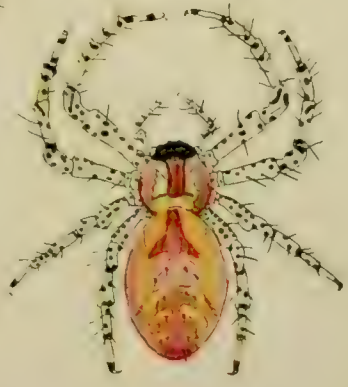


C

Plate II.

EXPLANATION OF FIGURES

Plate I—*Peucetia viridans:*
Adult female. X4.

Plate II—*Peucetia viridans:*
Fig. B. Young, 3 days old. X20.
Fig. C. Young, 13 days old. X20.
Fig. D. Young, 22 days old. X20.
Fig. E. Young, 39 days old. X20.

Plate III—*Peucetia viridans:*
Fig. A. Adult female. X4.
Fig. B. Young, just emerged. X20.
Fig. C. Young, 25 days old. X20.
Fig. D. Young, 34 days old. X20.

Plate IV—*Aranea gemma:*
Fig. A. Adult female. X2½.
Fig. B. Young, just emerged. X10.
Fig. C. Young, 3 weeks old. X10.
Fig. D. Young, 4 months old. X10.

Plate V—*Latrodectus mactans:*
Fig.A. Adult female. X5.
Fig. B. Young, 13 days old. X15.
Fig. C. Young, 20 days old. X15.
Fig. D. Young, 34 days old. X15.
Fig. E. Young, 41 days old. X15.

Plate VI—*Lycosa sp.:*
Fig. A. Adult female. X4.
Fig. B. Young, just emerged. X12.
Fig. C. Young, 3 weeks old. X12.

Plate VII—*Phidippus sp.:*
Young, just emerged. X20.

Plate VIII—*Bothriocyrtum Californicum:*
Fig. A. Adult female. X2.
Fig. B. Young, 3 days old. X20.
Fig. C. Young, 1 month 3 days old. X20.
Fig. D. Young, 2 months 6 days old. X20.
Fig. E. 3 months 6 days old. X20.

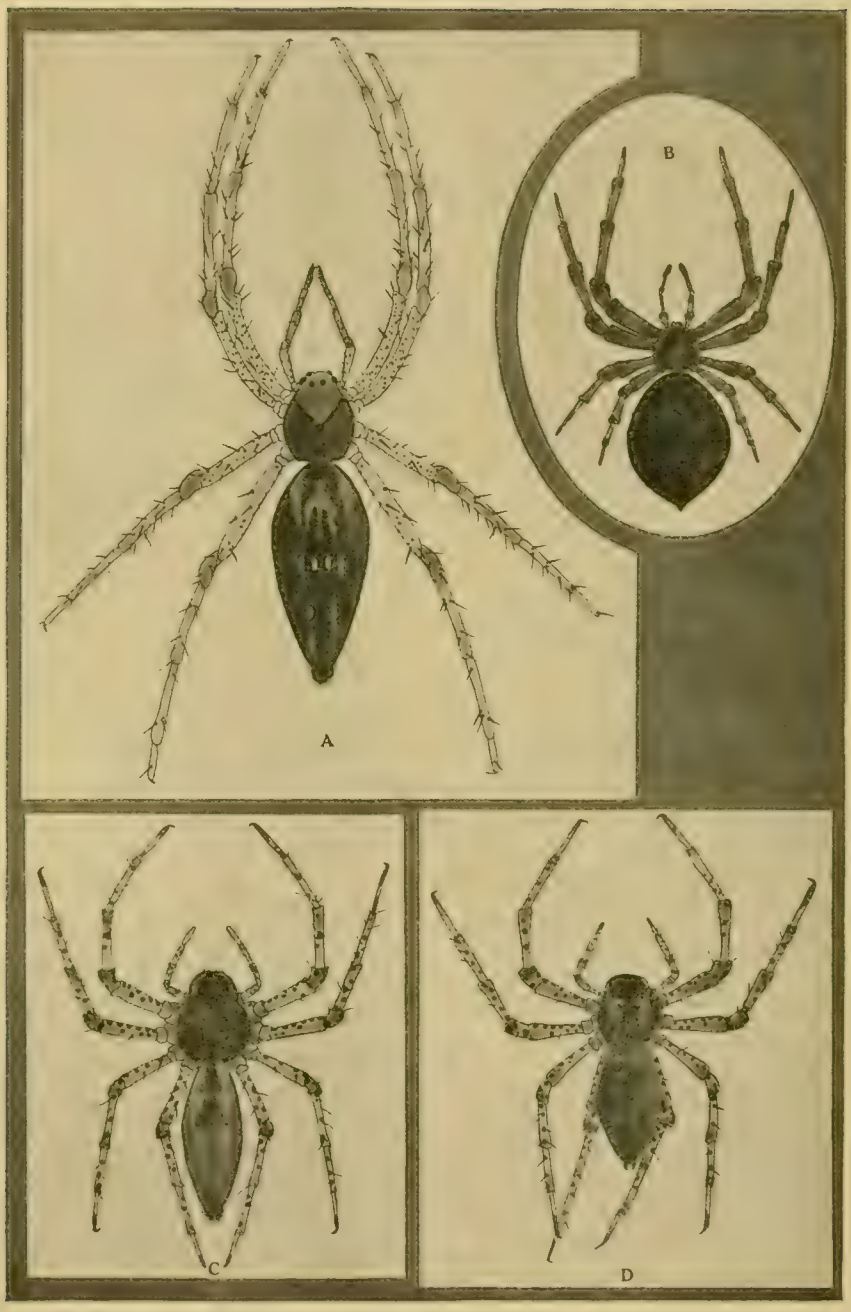
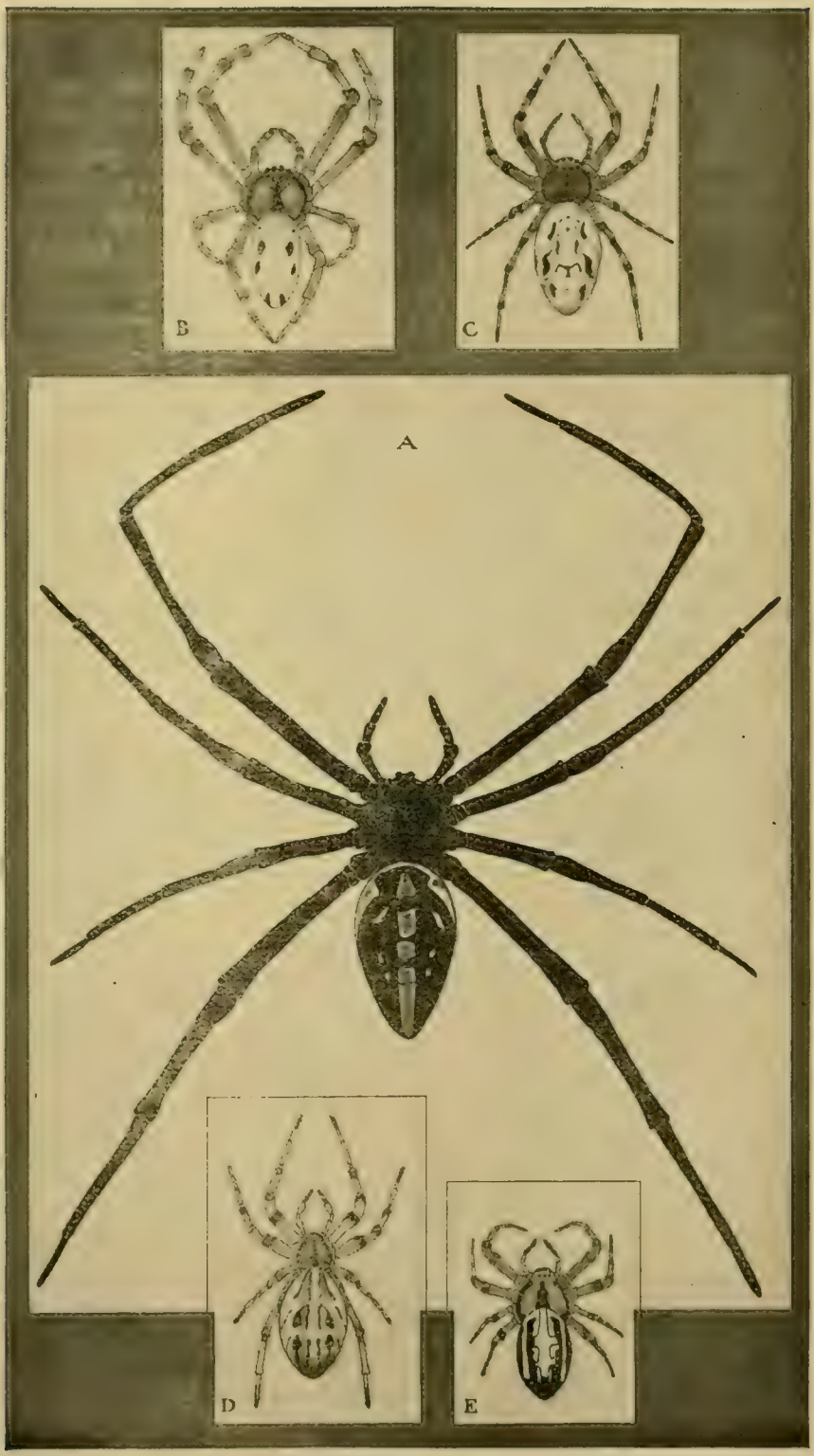


Plate III.

Plate IV.



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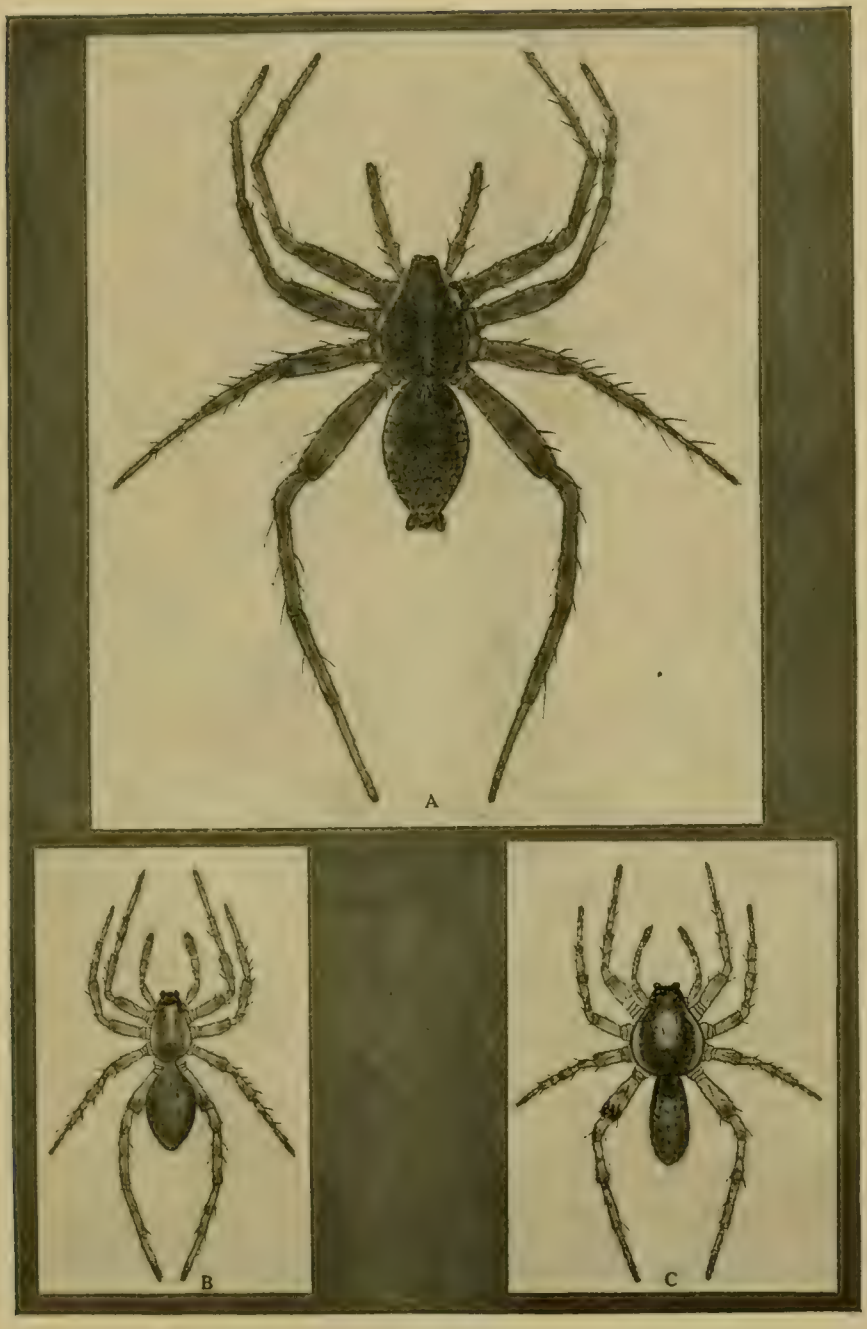

Plate VI.

Plate VII.

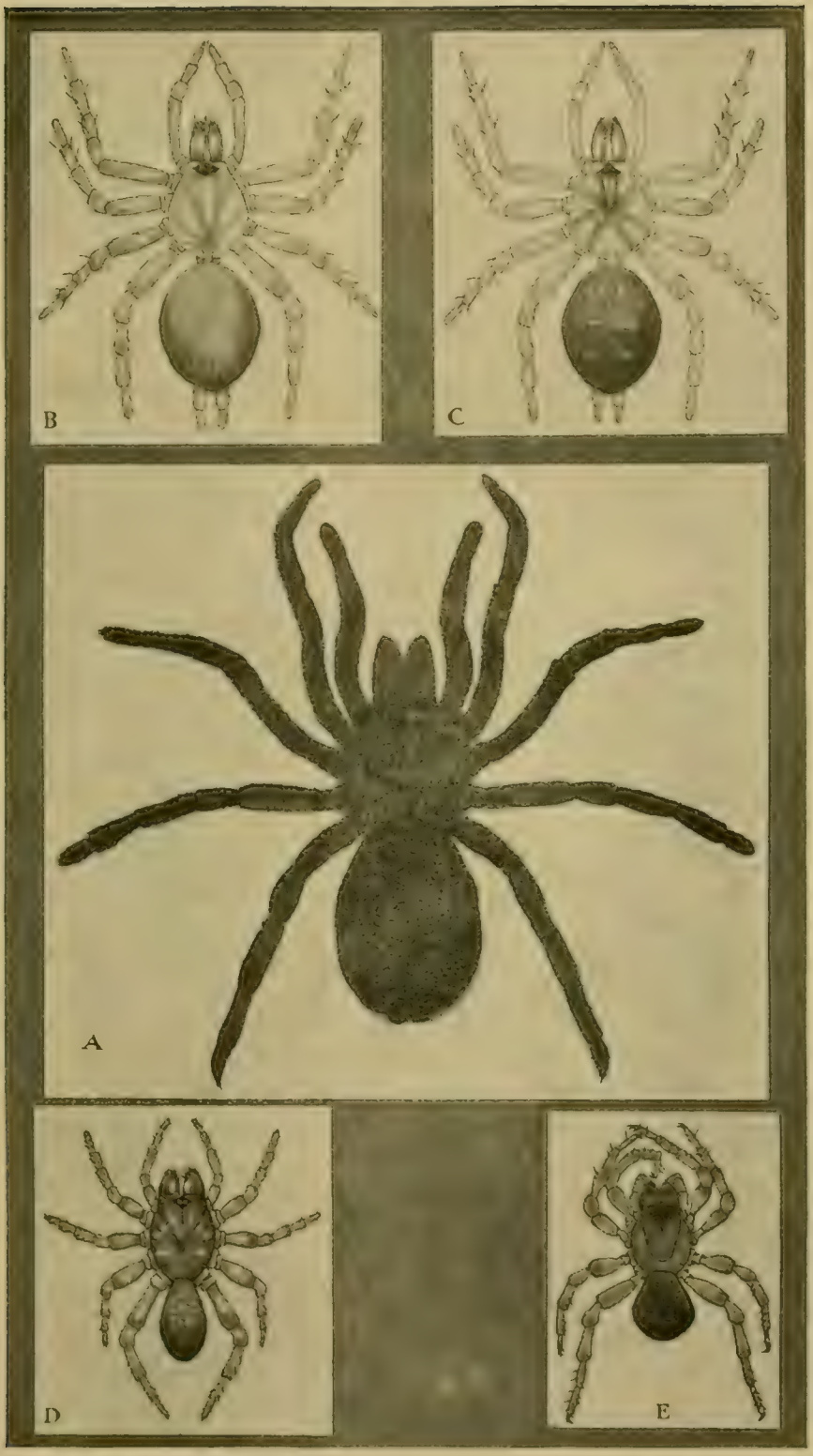

Plate VIII.

Studies in the Life Histories of Two Carpenter Bees of California, With Notes on Certain Parasites

H. H. NININGER

Xylocopa orpifex Smith

Systematic observation of this species was extended over a period of one year, beginning September 29, 1915.

Methods: The colony chosen for study is located on the summit of a small mountain rising from San Dimas Canyon of the San Gabriels, at an altitude of about 3,500 feet, where it occupies the timbers of a small, deserted cabin. It required two hours of climbing to reach the cabin from the foot of the mountains. About sixteen trips were made at intervals during the whole autumn, winter and spring and one in late summer. Pieces of timber were brought to the laboratory from time to time, and opened. During the breeding season those occupied by eggs or larvæ were carefully preserved and prepared for daily observation by splitting the timber so as to expose the contents of the cells when the parts were separated, and again refitting the parts and holding them in place by means of clamps when not under observation; or, by smoothing the split surface and carefully fitting a piece of glass over the opened cells, which was then held in place by means of glue or other paste. In one case a tightly-fitting sliding glass plate was used quite successfully. A dark cover of some kind was kept over the glass, except during observation, thus preserving as nearly as possible the natural conditions. As a check on the whole study a trip to the cabin was made at the season of their emergence and a number of cells were opened which seemed to corroborate all of the conclusions reached from the experiment, except in the case of certain parasites as noted below.

Habits: Orpifex shows a decided preference for redwood as a medium in which to burrow. Though I found them, in one or two cases, using Oregon pine. It shows no inclination to choose decay-

ing timbers; but, on the contrary, was always found working in the sound wood. This, I think, is a wise choice, for one of its dangerous foes is found abundantly, tunneling through decaying redwood. The surface chosen for making an entrance is generally vertical or slanting. When slanting or, as is sometimes the case, horizontal, the under surface is always chosen. For a short distance the burrow takes a course nearly or quite at right angles to the surface entered, then gradually changes to a course parallel to that surface, and always (with very few exceptions) leads upward in the slanting or upright timber. These tunnels vary in length from one inch to twelve inches and are, as a rule, remarkably straight. I am at a loss to know certainly what guides these interesting little carpenters in the construction of so straight a tunnel. My first idea was that they followed the grain of the wood, but in one case, where a knot occasioned a decided curve in the grain of the wood, the tunnels had been constructed straight as usual (Fig. 7). The most reasonable explanation seems to be that the vibrations of the wood serve to indicate the distance from either surface, for when boring in a plank only 5/8-inch thick they keep a line remarkably nearly equidistant from the two surfaces and never have I seen where they broke through to the surface. But a fact in the way of this theory is that they sometimes make tunnels just as straight in a 2-inch timber with the distance from one surface several times greater than the distance to the opposite surface. It is an interesting point which I have not yet solved to my satisfaction. My description fits the majority of tunnels. In a very small percentage of the cases studied, the tunnels were short and seemed to be in almost any position.

The excavation of these tunnels is evidently a laborious task, though the little creatures ply their trade with great avidity, and while at work they are not at all easily disturbed. The writer watched one of these patient workers for three hours, during which time she kept her mandibles working away continuously, leaving her work only twenty-five minutes, evidently for "lunch," after which she returned to resume her task. By closest scrutiny I was unable to see that the two and a half hours of labor had lengthened her burrow. I returned six days later to find her still vigorously pursuing

her task, but she had advanced less than one inch. Fig. 1 shows this tunnel and the rate of progress. It seemed to be a typical case. I have known one tunnel to be several weeks under construction. Their average length is from four to six inches. Those of greater distance, I think, are the result of more than one season's work, having been lengthened from year to year.

While digging, the bee slowly turns in the burrow, requiring from thirty minutes to an hour to complete the cycle. Observation showed no regularity or uniformity either in rate or direction of turning.

I have never found orpifex except in reasonably large aggregations. If some adventurous female begins work in a new locality, that locality is sought out by others until almost every available timber is honey-combed with tunnels*. From one surface entrance there are usually several tunnels leading away. Figs. 8 and 9 are typical in this respect. This habit doubtless serves well in the reduction of labor and also reduces the danger from enemies. A third advantage gained is the mutual protection against changes of temperature during the winter, for I found these tunnels, on cold days, literally packed full; in many cases two rows of bees lying side by side in the same tunnel.

Other than the points mentioned I find no hint of true community life. Males and females are about equal in number, and in the rearing of young they behave as other solitary bees so far as I am able to learn. No food is stored for winter but on warm days they come forth in search of food, a temperature of about 20 deg. to 21 deg. C. being sufficient to invite them out.

Life History: Having finished her tunnel the female begins to provision it with bee-bread which she makes from pollen and regurgitated nectar. After accumulating a mass about as large as her own body she lays an egg upon it and walls up that part of the burrow with a partition of chips of wood cemented together in the form of a spiral (Fig. 2), as Comstock has described in the case of *Xylocopa virginica*. Examination showed no uniformity in the direction of this spiral. I found among the partitions built by the

*This may be due to the scarcity of redwood in this vicinity.

same bee those in which the spiral turned clockwise and others in which it was the reverse. Five to six such cells are thus provisioned and sealed in about as many days, each occupying about five-eighths of an inch of the tunnel.

These eggs are hatched successively after an incubation period of about one week. The newly-hatched larva is a footless grub about 7 mm. in length. It feeds slowly at first, then more rapidly and has devoured all, or nearly all, of its food in from 22 to 28 days, when it ceases to feed and for a period of from 15 to 19 days shows very little change. During the non-feeding larval stage it spends most of its time in the position shown in Fig 3, but occasionally indulges in a series of writhing movements which last for a half minute or more. At the end of this period the first moult occurs, the beginning of the pupal stage (Fig. 11). The pupa is at first white and manifests even less movement than in the previous stage, but gradually pigment begins to develop and within three or four weeks the jet black color of the adult shows as a slaty blue through the thin white outer skin. About this time the pupa begins to show a bit more activity and within a few days may be found stretching out its legs and antennæ which have thus far been tightly folded against its body. This action is prophetic of emergence and a few days later the second and last molt occurs, which brings it into the adult stage. It remains only for its wings to complete their growth and harden before it is ready for flight.

But there are obstacles ahead of this seeker of the open air. The neatly-formed partitions are yet as strong as the day they were made, and there may be from three to six of them between young orpifex and the light of day. That is not all, for unless some wanton parasite has entered, there lie as many brothers and sisters, all yet in their swaddling clothes—in those chambers which form the only path to the out-of-doors. Some writers have suggested that this first-born politely waits here in this inner chamber for the younger members of the family to emerge and then humbly follows them out; but my observation revealed no such modest altruism. When No. 1 of a family of six emerged during a day of my absence she tore away the enclosing partition, kicked the occupant of the next cell back into the one she had deserted, and repeating this oper-

ation in each cell, went plowing through the whole row, and when the timber was opened the next morning No. 1 was found in cell No. 6 ready to tear away the last restraining wall. In some cases the first to emerge did wait for a short time before beginning to dig out, but this was not the rule. I think this matter is probably governed by the food supply. If these was a fragment left from the larval feeding it will satisfy the newly-emerged one for some time, but if not, it soon seeks a way out. These creatures seem to be ravenously hungry upon their emergence (as might be expected after sixty days of organization and development without taking any food) and their first activity is a search for food. After searching through their own tunnel and devouring what fragments remain they do not fly at once but enter adjoining burrows and profit by any morsel which may have been left by the early death of a neighboring larva or the failure of an egg to hatch.

The question has been raised as to a uniform position of the males and females in the brood tunnel (Davidson, Ent. News, Vol. 4, 1892). I noted at least one exception to such a rule, the first of one brood being a male and the first of another brood being a female.

Parasites: The most interesting of the parasites found upon this species was one of the Bombyliidæ, *Spongostylum delila* Loew, which first appears upon the foodmass as a very minute but exceedingly active larva. Even before the egg of the host is hatched this almost microscopic intruder is found industriously creeping about, rearing and stretching as if looking for a foe to conquor. For three weeks or more it thus restlessly creeps about over foodmass, egg and larva, feeding promiscuously, then finally settles down and, fastening itself by means of its hooked beak to the sixth or seventh segment of the Xylocopa larva (Fig. 12), it quietly feeds until its host is devoured unless shaken loose by the writhing movements (noted above) of the larva, when it soon reattaches itself and resumes its quiet feeding. The parasite is four weeks, or more old when it thus attaches itself and is found to be only three to five mm. in length. For nearly two weeks more its growth can scarcely be noted except by careful measurements so that at the age of five and one-half to six weeks its length is but from four to five mm. Here a remarkable

change occurs. It now begins to grow at such a rate as to almost double its size within twenty-four hours. The host, which heretofore has betrayed no marked injury from its enemy, now rapidly shrivels up. Only five days of this voracious feeding reduces the once large plump larva to an empty skin and in its place we find the equally large and plump, fully grown larva of the bombyliid (Figs. 3 and 4). This long retarded growth followed near the end of the larval period by a relatively short period of unusually rapid development seems to be a very advantageous adaptation on the part of the parasite. If growth had progressed steadily from the first, death of the host had surely resulted before the full development of the parasitic larva. This larva now rests almost motionless for ten or twelve days (Fig. 4) when it becomes a little more active and moults about two days later, entering the pupa stage (Fig. 5). In this stage it remains for fifteen to twenty days and emerges as an adult (Fig. 10).

The work of this parasite for the season in which it was studied was quite general, about ten per cent. of the cells examined being infected. So far as I observed, its work was also very equally distributed—about half the broods showed one parasitized larva and in only one case was there more than one found in the same brood.

Other parasites found were a phycitid moth and a tenebrionid beetle, both of which began their work upon the bee-bread and when that supply ran short devoured the young bees. These two parasites would doubtless be much more destructive were orpifex a less careful workman; for I found that where cells prepared for study were not tightly sealed the pupæ were in almost every case devoured. But where the partitions were left entirely intact and the glass cover glued on tightly I found only one case in which a cell was entered and in this case the tenebrionid bored through the partition to deposit eggs within the cell. In some cases I used bee-bread to paste the glass cover over the opened cells and in every such case these two parasites found their way in by feeding upon this material and without fail they devoured the pupæ before they emerged. From my examination of cells which had not been opened before the season of emergence I conclude that the injury of these parasites is slight except in case of defective construction of partitions. But they were found occasionally even in the normal brood cells.

Mites of the genus *Trichotarsus* (determined by Nathan Banks) infested a few nests and in some cases destroyed developing bees but often the emerging adult carried them away among the hairs covering the thorax and seemed to be uninjured.

All the parasites have been sent to specialists for determination. The tenebrionid was determined for us by H. C. Fall. It proved to be *Aphanotus brevicornis* Lec.

The bee-fly seems not to be the same species as the one found by Davidson, Ent. News, Vol. 4, 1892. Prof. J. M. Aldrich has determined it for us as *Spogostylum delila* Loew.

The moth sent to the U. S. Museum was in such a condition that it could only be determined to belong to the family Phycitidæ.

Xylocopa varipuncta Patton

This species is much larger than orpifex and exhibits a marked dimorphism, the male being of a golden brown color while the female is jet black. It inhabits the valleys and lower hill regions while orpifex is found in the higher hills and mountains.

Varipuncta seem to prefer wood that is partially decayed in which to burrow. I have found them working several kinds of wood, but most abundantly in live oak, pepper and eucalyptus. Their tunnels are generally from five to twelve inches in length and seem to follow the grain of the wood, sometimes far from straight. Their nesting habits are similar to those described for orpifex. They are not so much inclined to live in groups as the former species; yet in one case I found several individuals using a common surface entrance from which each constructed a separate tunnel for her brood nest.

My study of this species was not so extensive as in the case of orpifex and only one parasite was found, the mite, *Trichotarsus*, which destroyed a small percentage of the larvæ. This mite is often found upon the adult which I think accounts for its presence in the brood chamber. The life history, as far as known, is given in table below:

	Egg-stage	Feeding Larva	Non-Feeding Larva	Pupa	Total
Xylocopa orpifex.....	7 days	23-28 days	18-19 days	40-45 days	85-99 days
X. varipuneta.....	about 1 week	30 days	20 days	40 days	
Bee Fly (parasite)....	unknown	42-47 days	12-15 days	15-20 days	

DISTRIBUTION (From T. D. A. Cockerell)

X. orpifex: Mountains near Claremont (Baker; Oak Creek Canyon, Ariz. (Snow); Rock Creek, Cal. (Davidson); Strawberry Valley, San Jacinto Mountains, Cal. (Grinnell); Mountain View, Cal. (Ehrhorn). This species occurs from Nevada south to Lower California.

X. varipuncta: Tempe, Ariz. (Irish); Fort Mohave, Ariz. (Junius Henderson); Los Angeles, Cal. (Cockerell), on flowers of *Datura meteloides.* Also reported from Texas and Lower California, but not in New Mexico.

(Contribution from the Zoological Laboratory of Pomona College and Lordsburg College)

PLATE I.

Figure 1. Shows progress in excavating tunnels: *a*, bottom of newly begun tunnel when found; *b*, bottom of same tunnel after six days of work. Nat. size.

Figure 2. One of the partitions as viewed from the entrance of the burrow.

Figure 3. X. orpifex larva in non-feeding stage with bombyliid larva attached. Nat. size.

Figure 4. Same as Fig. 3, but five days later, showing X. orpifex larva reduced to empty skin and parasite larva fully grown. Nat. size.

Figure 5. Pupa of bombyliid. X2.

Figure 6. An egg of X. orpifex with outline of developing embryo inside. X3.

PLATE II.

Figure 7. A tunnel of Xylocopa orpifex showing where the worker did not follow the grain of wood. Nat. size.

Figures 8-9. Show two pieces of ¾-inch boards with one surface hewn away to show work of X. orpifex . X shows position of surface entrances with a number of tunnels from each, reduced.

Figure10. Adult of bombyliid parasite.

Figures 11-12. Larva of X. orpifex with bombyliid larva attached; much enlarged. Pupa of X. orpifex; much enlarged.

Figure 11. Larva of X. orpifex with bombyliid larva attached. Much enlarged.

Figures 11 and 12 from drawings by Margaret L. Moles.

PLATE I.

PLATE II.

Albert John Cook, DSC.

Professor of Biology in Pomona College, 1894-1911

DAVID L. CRAWFORD

On September 29, 1916, a very great and noble career was brought to a close, when Dr. Albert John Cook passed away to his eternal rest. Few men have had the privilege of exerting a greater force for good among college students than was exerted by Dr. Cook, for he was more than a teacher of biology—he taught men and women the way to large service in the world and to clean and high and noble living. Hundreds have been made better and purer by their contact with this great teacher, and scores have gone out of the college to a large career of unselfish Christian service because "Prof." Cook touched their lives and made them see things in the large. Colleges and universities need more men of this type, for they are very rare indeed.

Pomona College has not had a more loyal supporter than was Dr. Cook. Through all those early years he remained and fought loyally for the existence and the development of this institution, all the while giving of his time and money and influence to build up the scientific side of the college. Much of the present museum assets are directly the fruits of his labor and much of the laboratory equipment was secured by him, but, greatest of all, the good name of the college and of its biology department was built up through his sending out of well equipped men ready and eager for large service in the state and nation.

Not only does Pomona College mourn the passing of this man, but the entire state of California and indeed the nation has suffered a great loss, for he was assuredly a national figure in his sphere. When most men are retiring to a quiet life, Dr. Cook at the age of nearly seventy years went from his place in Pomona College to a larger and even more active sphere of work. From 1911 to nearly the time of his death he served the state of California in a most successful manner as the head of the Commission of Horticulture. He drew this work out of the mire of politics and made it a benefit

to the agriculture of the state. This work proved to be very wearing upon him, however, and aggravated an ailment of long standing in his spine. Seeking relief from this trouble he at last resigned from his state position and traveled east to place himself under the care of a specialist. Relief did not come, however, and the man at last succumbed after several months of enforced inactivity.

Dr. Cook was born in Owasso, Michigan, August 30, 1842, and passed his boyhood in that state. In 1862 he graduated from Michigan Agricultural College and then was a graduate student in Harvard University for a year. He then returned to his Alma Mater as professor of entomology and zoology in which position he remained until 1893. In that year he came west to California and from 1894 to 1911 was professor of biology in Pomona College. In 1911 he went to Sacramento, but retained his connection with this college as emeritus professor. On September 29, 1916, in his boyhood home in Owasso, Michigan, he passed on from his arduous labors on this earth to his great reward.

The Central Nervous System of Serpent Stars

WILLIAM A. HILTON

Several summers ago the activities of small serpent stars attracted my attention. The young of *Ophioderma panamensis* Lutken, possibly mingled with the minute young of *Ophionereis annulata* Le Conte were found in great numbers at Laguna Beach. These little creatures seemed fully as active as the adults. As compared to mature forms they were often very minute, the diameter of the discs being one-tenth or one-twentieth that of the adults.

As compared with the starfish the adult nervous system is, of course, more highly organized although as well known it follows the same general plan of arrangement. In the adult form studied, *Ophioderma,* the larger more superficial or epineural nerve bands were best marked and were chiefly studied. The hyponeural nerves were not prominent or well separated from the epineural. The large pedal ganglia are well marked and of the same general structure as the radial parts of the epineural strands, but the cells seemed a little larger and the fibers not quite so marked in the same preparation.

In some quite small serpent stars where the radial and circumoral systems were compared although the structure was the same in general, the more central part of the nervous system was much larger. In a specimen with a disc one milimeter in diameter the radial was about half the diameter of the circumoral. This would indicate more of a centralization than in the starfish.

A section across the radial nerve shows the nerve cells similar to those in starfish, located in the outer zone, two or three cells deep. The wider fiber area is quite homogeneous in some preparations but in others there were here found large numbers of cell processes similar to those of starfish. Certain rather fortunate slides showed these processes with great clearness. The best results of this sort were obtained from specimens fixed in Flemming's fluid, the calcium salts of the skeleton were afterward removed by means of acid

alcohol, sections were cut in paraffine. Some sections were stained with iron hematoxylin, but some were mounted unstained and occasionally a very fine Golgi-like impregnation of certain cells with their branches was evident. From such preparations it was learned that the cell processes were about one to a cell and that this often branched at half its length or a little more, although it was difficult to make this out because of frequent crossing of the fibers. Most cells seemed to be uni- or bi-polar, but some had other branches running back among the cells of the celular area. In some places the long fibers from the cells were very wavy and they often ran slantingly, crossing many cell processes, some may have been larger than others, although it was impossible to be sure of their comparative size because of differences in position and staining. In small specimens smaller fibers or fibrils were evident and very numerous. In this, as compared with the starfish studied, there was more the indication of fibrillae, but no marked development of these. On the whole, the central nervous system seems more like the complex systems of other forms than does starfish.

The nerve cells are well marked, sometimes with nucleoli and with much chromatin but not usually with the characteristic arrangement of chromatin material. In some cases a small amount of material in the cytoplasm gave the appearance of tigroid substance. As in starfish, fibers from cells usually appeared as single fibrils especially in the adult. In many places the fibers or fibrils seemed to start rather abruptly from the outer zone of cytoplasm of its cell. In a few cases two fibers seemed to start from the same place in a cell, but this of course may have been where one of the fibers in crossing was cut off, or possibly fibers entering and leaving the same cell. The details of fibers and cells were taken from Flemming's fluid preparations either stained or unstained.

The segmental arrangement of ganglia in the arms is one of the well known features which forms such a striking resemblance to the ganglionic cords of many segmented animals. In some of the smaller specimens the condition of the gangila is especially well marked, towards the ends the nerve strand becomes quite reduced. In longitudinal sections of the arms of serpent stars the thicker cell area is, of course, that of the superficial radial nerve while the cells

of the closely applied deeper or hyponeural nerves seem like the less numerous dorsal nerve cells of the ventral ganglia of arthropods and annelids. It is understood by some that the epineural nerves are sensory in function, the hyponeural motor, if this be so then the statements in a number of places in literature that the ventral cells of certain arthropods are sensory and the dorsal cells are motor in function seems not without interest.

Upon comparing the size of the ganglia of small serpent stars with those of adults, it was found that the nervous system is in proportion, much better developed in the small specimens. All the larger figures shown were drawn to the same scale, yet the figures of the adult were from a specimen with a disc fifteen times that of the small specimens. The radial nerve of the small specimen shown in cross section is through its narrowest part. In a small specimen of 1 mm. disc diameter the radial nerve was one-third of the diameter of the arm. In an adult but small specimen the arm was 3.5 mm. in diameter while the nerve strand was only .04 to .01 mm. in diameter. The nerve cells were slightly more numerous in cell areas in the small specimens than in the large.

SOME POINTS SUGGESTED BY THESE OBSERVATIONS

1. The synapse in this form and probably other echinoderms seems to be by simple contact, possibly at the sides as well as at the terminals of nerve cells.
2. If fibrils are found within nerve cells they are represented by very few, possibly only one to a fiber in many cases.
3. Some slight indications of tigroid substance were found.
4. With the growth of the nervous system the nerve cells become less abundant at any one place while the relative size of the nerves becomes much less in the adult.
5. The nervous system of the serpent stars looks much more like the nervous structures of more complex forms than does that of the starfish.
6. A striking general resemblance of the nervous system to the segmental arrangement of the ganglia of arthropods and annelids is shown in the arms of serpent stars.

7. The close application of the deep strands to the superficial gives the appearance of dorsal and ventral cells in the ganglia of segmented animals. The suggestion of a dorsal sensory part and a ventral motor has interest if not importance in this connection.

8. A simple condition of relationship of nerve cells to each other seems evident in the radial and circumoral strands of this form as well as in starfish and these conditions may have an important bearing in understanding the more complex relationships of other species. If the conditions here simply shown are not exactly reproduced in vertebrates or arthropods, they may give some indication of the way in which the more complex have come about.

9. If the more superficial parts of the radial and oral system are sensory and the smaller dorsal parts motor, then it seems that the larger ventral strand must be a little more than sensory, as has been shown by numerous experiments, because of its size and because of its inter-relationships. In other words we have here the origin of a central nervous system or associating part from a sensory portion. This may be an important suggestion in connection with the origin of the central nervous system in other forms.

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(Contribution from the Zoological Laboratory of Pomona College)

EXPLANATION OF FIGURES

Figures 1-3. Cross sections through the superficial radial nerve of an adult serpent star. X350.

Figures 2 and 3 do not show the whole breadth, and Fig. 2 shows a little of the deeper more dorsal nerve area.

Figure 4. Section through the pedal ganglion of an adult. X350.

Figure 5. Section through the circum oral strand of a serpent star of 1mm. disc diameter. X350.

Figure 7. Cross section through the narrowest part of the radial nerve strand of a 1 mm. serpent star.

Figures 8-9. Longitudinal section through the nervous system of the arm of a 1 mm. serpent star. X75.

Figure 10. Nerve cells from the nerve strands of adult serpent star fixed in Flemming's fluid. X700.


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VOLUME EIGHT NUMBER ONE

JOURNAL OF ENTOMOLOGY AND ZOOLOGY

MARCH, 1916

PUBLISHED QUARTERLY BY
POMONA COLLEGE DEPARTMENT *of* ZOOLOGY
CLAREMONT, CALIFORNIA, U. S. A.

CONTENTS

Entered at Claremont, Cal., Post-Office Oct. 1, 1910, as second-class matter, under Act of Congress of March 3, 1879

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EDITED BY POMONA COLLEGE, DEPARTMENT OF ZOOLOGY

Subscription $1.00 to domestic, $1.25 to foreign countries.

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THE JOURNAL OF ENTOMOLOGY AND ZOOLOGY

William A. Hilton, Editor

Claremont, California, U. S. A.

VOLUME EIGHT NUMBER TWO

JOURNAL OF ENTOMOLOGY AND ZOOLOGY

JUNE, 1916

PUBLISHED QUARTERLY BY
POMONA COLLEGE DEPARTMENT *of* ZOOLOGY
CLAREMONT, CALIFORNIA, U. S. A.

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William A. Hilton, Editor

Claremont, California, U. S. A.

VOLUME EIGHT NUMBER THREE

JOURNAL OF ENTOMOLOGY AND ZOOLOGY

SEPTEMBER, 1916

PUBLISHED QUARTERLY BY
POMONA COLLEGE DEPARTMENT *of* ZOOLOGY
CLAREMONT, CALIFORNIA, U. S. A.

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William A. Hilton, Editor

Claremont, California, U. S. A.

VOLUME EIGHT NUMBER FOUR

JOURNAL OF ENTOMOLOGY AND ZOOLOGY

DECEMBER, 1916

PUBLISHED QUARTERLY BY
POMONA COLLEGE DEPARTMENT *of* ZOOLOGY
CLAREMONT, CALIFORNIA, U. S. A.

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